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CONSTRUCTION OF AN ALGORITHM FOR STEM RECOGNITION IN THE HEBREW LANGUAGE. APPLICATION OF HEBREW MORPHOLOGY TO COMPUTER TECHNIQUES FOR INVESTIGATION OF WORD ROOTS.

BY- LAZEWNIK, GRAINOM
NEW YORK UNIV., N.Y.

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THE OBJECTIVE OF THIS PROJECT WAS TO DEVISE AN ALGORITHM FOR A STEM RECOGNITION PROGRAM DESIGNED TO SEARCH FOR THE ROOT OF ANY HEBREW WORD AS WELL AS TO DETECT INNER CHANGES ON THE GIVEN ROOT. SUCH AN ALGORITHM COULD BE USED IN LIBRARY CATALOGING AND IN CREATING INDEXES AND CONCORDANCES OF TEXTS IN THE HEBREW LANGUAGE. IN THIS STUDY THE HEBREW WORD WAS CONCEIVED AS A CONSONANTAL, MORPHOLOGICAL UNIT. CENTRAL TO THE ENTIRE RESEARCH WERE TABLES AND LISTINGS ORGANIZED ON A GRAMMATICAL BASIS AND SO DEVISED AS TO PRESENT CERTAIN PERTINENT CORRELATIONS BETWEEN VERBALS AND NOMINALS AND THE AFFIXAL ELEMENTS. THIRTY-SIX GRAMMATICAL CATEGORIES WERE SET UP. FOUR TYPES OF AFFIXES WERE CORRELATED WITH THESE CATEGORIES. THE COMPUTER TECHNIQUE CONSISTED OF FRACTIONATING TEST WORDS INTO PREVIOUSLY DEFINED ELEMENTS AND FORMING VARIOUS COMBINATIONS WHICH WERE SUBSEQUENTLY SUBJECTED TO VALIDATION. THE RESULT OF THE COMPUTER FUNCTIONING REMAINED VALIDATED BY OBJECTIVE CRITERIA. A SPECIAL REFERENCE DICTIONARY IS NOW BEING COMPILED FOR THE PURPOSE OF TESTING THE RESIDUUM OF GRAMMATICALLY LEGITIMATE COMBINATIONS. (AUTHOR/DO)

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Application of Hebrew Morphology to Computer Techniques for Investigation of Word Roots

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Rabbi Grainom Lazewnik

February, 1968

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New York University

New York, N. Y.

Sponsoring Committee: Prof. Abraham I. Katsh,
Prof. Jack Heller, Ass. Prof. Alice M. Pollin

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Application of Hebrew Morphology to
Computer techniques for Investigation
of Word Roots

GRAINOM LAZEWNIK

June, 1968

"A dissertation in the Departmentof Hebraic and
Near Eastern Studies submitted to the faculty of
the Graduate School of Arts and Science in partial
fulfillment of the requirements for the degree of
Doctor of Philosophy at New York University."

Approved___________________
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INTRODUCTION

Since Hebrew is a highly inflected language, it presents special problems with reference to utilization of electronic machines for the construction of reference works such as large scale indices and concordances. Such literary references and sources as an index and concordance must be arranged according to alphabetical order of verb roots and nouns stripped of all auxiliary appendages. Any attempt to make an alphabetical listing in Hebrew requires a thorough knowledge of Hebrew grammar and the ability to recognize the various additive elements and so distinguish them from the root. This is the basic condition which must preface such intended use of an electronic computer. This constitutes the motivation for our study.

In reality, the problem confronting our research, the problem the solution of which would constitute the contribution made by our study and justifying our study, is not a further classification and another variety of systematization of elements and units of the Hebrew language, which in bulk are familiar matters, but in the ferreting out, so to speak, of hidden unsuspected relationships involving radical elements and the introduction of an original, effecient and wide-ranging computer technique of broad application in the wake thereof.

In general, the course of the project consisted of first preparing correlation tables of required Hebrew elements, adapted to the programming process, and then the construction of the special reference dictionary.

Irregulars

This study took no account of rare irregulars which characterize Scripture, such as the *scriptio defectiva*, e.g. *QM QLT* (קם קלת), *QuM*, *QoLoT* (קום קולות)[1] or an additional *Nun* (נ) for the third person plural, as in *YaD'uN* (ידעון) for *YaD'u* (ידעו),[2] or plural for singular, e.g. *TiQR'Na* (תקראנה) for *TiQRa* (תקרא),[3]

---

[1] *QM*, Joshua 7:13, *QLT*, Exodus 9:23.

[2] Deuteronomy 8:16.

[3] Exodus 1:10. The same example illustrates another peculiarity of Scriptural Hebrew: namely, the change of *He* (ה) to an *Alef* (א).

or the rare variant for third person, feminine, singular of the perfect, represented by YZ'T (יצאת) and B'T (באת), found in the Mišna.[4] This was found necessary, for otherwise there would not be the underlying assumption of the complete superiority of grammatical rule within our sphere of study. For those interested in that phase of Scripture concerned with the irregulars, many specialized works are available to aid in the study.

This study is moreover premised on the existence of the standard construction BiNYaNiM (בנינים) only. The certain grammatical authorities[5] list many additional forms, vestiges of archaic constructions, but the accepted view is that these represent exceptional verb roots and were thus so treated in this study. Examples of these additional forms are Taf'el (תרגל), Šaf'el (שעבד), etc.

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[4] Šabat, 57a.

[5] Z. Har Zéhav, Diqduq Hallašon Ha'Ivrit, Vol. 3, part 2, pp. 408-476.

Method of Transliteration

The technique of the study necessitated adoption of a satisfactory system of transliteration. In fact, two such systems were utilized. In actual composition of this draft of the thesis, the Precise Méduyaq (מדויק) system established by the Academy of the Hebrew Language[6] was used. This system is characterized by a one to one correspondence of Hebrew and Latin alphabet. I modified this by personal choice of ' to represent *Alef* (א) and ! to represent *!Ayin* (ע) for reasons of convenience. More urgent reasons, however, determined more radical modifications. This study, vis-a-vis the computer, was premised exclusively on the basis of the consonants of the Hebrew language. The consonantal vowels, however, posed a problem. By adopting the rule of exclusive and indiscriminate concern with the script, the consonantal vowel could be treated as a regular consonant when related to orthographical changes and retain the regular consonantal transliteration, e.g. *QoŠṬoT* (קושטות) would be transliterated *QWŠṬWT*. For the convenience of the reader, at times both forms have been used, e.g. *WLHQŠYṬ* (*ULHaQŠiṬ*).

For the actual input fed to the computer, the IBM system was employed. The latter consists of a one-to-one correspondence in order of the English and Hebrew alphabets starting with *Bet* (ב)

---

[6] *Killĕ Hatta'ătik Miktav !vri Liktav Latini*, (Principles of Transliteration from Hebrew Script to Latin Script), The Academy of the Hebrew Language, Jerusalem, 1956-57.

which corresponds with A. For Alef (א), the symbol ⊕ was used. (See below.)

The radical QŠṬ was adopted as a model in place of the traditional P!L (Pa!al) (פעל) in order to avoid the complications introduced by the semi-vowel (חטפים) as well as the change in sound of the Pe (פ) from p to f by elimination of the dagéš in conjugation. The conventional radical QṬL has been rejected because of its connotation.

In designating verb classes the conventional Hebrew symbolization is employed, based on the one-to-one correspondence of the consonants of Pa!al (פעל), Pe, Ayin, Lamed, with the respective letters of the given radical.

The consonants M, N, Z, P, K (מנצפך) present no confusion because of their variation in form as final letters since the computer has been so programmed as to identify these in either form, final or not. A similar computer technique established reversal in reading from left to right.

__Transliteration System Fed to Computer__

Letter or Symbol Used	Hebrew Character	Name of Hebrew Letter
Θ	א	Alef
A	ב	Bet
B	ג	Gimel
C	ד	Dalet
D	ה	Hé
E	ו	Waw
F	ז	Zayin
G	ח	Ḥet
H	ט	Ṭet
I	י	Yud
J	ך	Kaf (final)
K	כ	Kaf
L	ל	Lamed
M	ם	Mém (final)
N	מ	Mém
Ø	ן	Nun (final)
P	נ	Nun
Q	ס	Sameḥ
R	ע	'Ayin
S	ף	Fé (final)

Transliteration System Fed to Computer (continued)

Letter or Symbol Used	Hebrew Character	Name of Hebrew Letter
T	פ	Pé
U	ץ	Zadi (final)
V	צ	Zadi
W	ק	Qof
X	ר	Rêš
Y	ש	Šin
Z	ת	Taw

Definition of Terms

This study employs a terminology which represents a usage both conventional and somewhat subjective.

VERB - has its regular significance

NOUN - includes all substantives and all other elements apart from verbs

CONSTRUCTION - one of the seven Binyanim (בנינים)

CONJUGATION - the forms of verb inflection

ROOT - the normal radical origin

STEM - the nucleus remaining after removal of all affixes

EYTaN - the prefixes (איתן) ', Y, T, N of the imperfect

List of Abbreviations

The following abbreviations have been used in the various tables and lists presented in the text:

Perf. - perfect
Part. - participle
Imp. - imperfect
Imper. - imperative
Inf. - infinitive
Inf. Con. - infinitive construct
Inf. Abs. - infinitive abstract
Hif. - Hif!il
Pi. - Pi!el
Pa. - Pa!al
Hof. - Hof!al
Pu. - Pu!al
Nif. - Nif!al
Hit. - Hitpa!el
P. - person
Fem. - feminine
Masc. - masculine
Pl. - plural

List of Abbreviations (continued)

Sing.- singular

P.P. - passive participle

P.P.Pr. - passive participle with pronouns

In. - index number

G. - gender

P.A.- pronominal affix

A.E. - Auxilary element

Constr. - construction (בנין)

Conj. - conjugation

L. - list

Suf. - suffix(es)

Gov. - governing, that govern

Pron. - pronouns

CHAPTER I

PROBLEM AND OBJECTIVE OF STUDY

Only recently have researchers achieved some success in attempts to use electronic data-processing techniques in the study of the Hebrew language.[1] The morphology of the Hebrew language appears to militate against such an undertaking. In the preparation of a concordance to work in the English language, it is possible to instruct an electronic computer to classify words mechanically in alphabetical order, for example. Such a classification would be of little value in Hebrew. Semitic verbs as well as verbal nouns are based on bi-,[2] tri-, or quadri-literal roots to which prefixes and suffixes may be appended. Such prefixes and suffixes may be prepositions or conjuctions; they may indicate tense, person, number or mood. If we take, for example, the verbal form WLHQŠYṬ (Ulĕhaqšiṭ) (ולהקשיט) (and to adorn), we could not classify it alphabetically under W--which is essentially the conjuction 'and,' nor under L--which is the preposition 'to,' not under H--which together with the Y simply indicates that the verb is causitive. The meaniful unit of the verb begins with the first root letter Q, and only a classification by such a root letter would be of significant value. Samples taken from various types of literature show that more than 90% of the words would require an indication of the root. A computer could be instructed to consider W-L-H as prefix letters but they as well as more than half of the twenty-two letters in the Hebrew alphabet may be used both as root letters and as prefixes and suffixes.

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[1] *Vide* References 1,2,3, 5,6

[2] Theoretically speaking only. In this study, however, for the sake of simplicity, no verbs have been considered as derived from bi-literal roots. See chapter on verb classification.

It would, of course, be possible to indicate the roots manually and punch the data along with the input text. Such a process, however, is impractical for Hebrew because root identification requires a thorough mastery of Hebrew grammar. Only an expert in Hebrew grammar would be capable of punching cards in this manner. All of this makes the use of the computer for data processing in Hebrew impractical, and may account for the fact that until today nothing has been done for the creation of a literary index or concordance to any Hebrew work by means of electronic devices. The need for concordances to major literary works is felt by every scholar, researcher, and educator in the field, but the time and expense involved in producing them manually has been a major obstacle. Library cataloguing is another field where electronic techniques cannot be utilized well in the Hebrew language because of the same problem.

In order to render the mechanical processing of Hebrew materials feasible, it would be necessary to devise an algorithm for a stem recognition program designed to search for the root of any Hebrew word regardless of any suffixes and prefixes, as well as to detect inner changes of the given root.

The objective of this project is to devise such an algorithm to be used for library cataloguing and for the creation of indices and concordances of texts in the Hebrew language.

CHAPTER II

MORPHOLOGY OF HEBREW

Auxiliary Elements[1]

Any primary research into the nature of the language requires a thorough understanding of its morphological aspects. It is therefore first necessary to review the laws of morphological change affecting the Hebrew language. Consider the realm of the auxiliary elements: the prepositional particals *B*, *K*, *L*, *M*, the conjuctive *W*, the definite article *H*, the interrogative *H*, the conjuctive *Š*, and the conjuctive Aramaic *D* naturalized into Hebrew. These present no special problem when used distinctly in conjuction with nouns or verbs, inflected or uninflected, with or without pronominals. The definite article *H* provides the only albeit uncomplicated exception, conspicuously illegitimate with respect to verbs and to possessive inflected forms. Combination of these elements, however, present very special difficulties in usage.

No criteria, however, have ever been established for the usage of combined prefixed articles, prepositions, and conjuctions which are used so commonly in Hebrew. For example,

---

1. Termed in Hebrew "*Otiyot Šimuš*."

in regard to the usage of the prefixed element, *WLKŠ* (*W*--the conjunction *and*; *L*--the preposition *at*, *to*, *for*; *K*--the preposition *like*, *about*, *as*; *Š*--the relative pronoun *that*, *which*), common in medieval Talmudic commentaries, but never found in Scripture, there is no fixed rule as to preferable usage; thus *W*, *L*, *K*, *Š* or *W*, *K*, *Š*, either affixed to *Ya!aSe* (Ya!ase) (יעשה) (he will do), are interchangeable renderings of "and when he will do." Again, *HaLeKéŠeYa!ăSe* (Halėkéšeya!se) (הלכשיעשה) (and when he will do...?) formed by the addition of the interrogative *H*, harmonizes with the aesthetics of the language, yet, its occurrences in the literature is rare. Its usage is completely ignored in modern Hebrew. Lexicons and grammars in general disregard the problem of criteria for combination-formations.

Understandably, since this is a matter of empirical judgment, divergencies of opinion are to be expected. A listing of affixes for modern Hebrew has already been proposed[2] but, a major change has been inserted in their treatment[3] as will be explained each in its place. I have further followed the course of rigor and included in my listings all possible combinations. My project has sought to

---

M. Sapiro, Y. Cheouka, "Nituah Mekanografi", *Leśonenu*, Vol. 27-28, P. 360, appendix 1

[3] Certain affixes have been ignored while new ones have been added. The compound auxilaries *LK* (לכ), *LM* (לם) and *KML* (כמל) have been dropped.

embrace the Hebrew drawn from all epochs and from all literatures. Obviously, specimens found in one type of literature do not necessarily occur in other types. Combinations found, for example, in medieval literature, are not found in Biblical and modern literature. The example already cited, HaLeKěŠeYa!ăSe, is in point here. Strict limitations whereby to set off the various literatures, of course, are not scientifically possible. The individual researcher will, however, be able to judge the approximate character of the literature he is studying. Because of the exhaustive[4] nature of my listing it will be possible to adapt it to any study purpose in this field whatsoever. The additional, extraneous information fed into the computer will not prejudice the accuracy of the analysis as long as the input of relevant data has been complete. Table A exhibits all possible functions of the indicated auxilaries.

Prefixes (Table B)[5]

The prefixes are distinguished from the auxilary elements by their greater grammatical inflexibility. They include: ', Y, T, N (EYTaN) (איתן), occuring in the imperfect;

---

[4] Auxilary elements only. Certain other types of affixes were omitted, perhaps arbitrarily from the study. This will be touched upon later.

[5] See Table B for all possible forms of prefixes in combination with the element governing varying grammatical functions.

(D)[6] *H* of *Hif!il*, *Hof!al* and *Nif!al*;

(D) *H* of *Hitpa!el* with transposition of *Taw* (ת) in verbs whose first radical is *S* (ס) or *Š* (ש),

e.g. *HiSTaDéR* (הסתדר), *HiŠTaMéR* (השתמר);

(D) *H* of *Hitpa!el* with the coalesced *Taw* (ת) in verbs whose first radical is: *D* (*Dalet*) (ד),

e.g. *DBQ* (דבק);

T (*Tet*) (ט),

e.g. *THR* (טהר);

or *T* (*Taw*) (ת),

e.g. *TMM* (תמם);

and the exceptions of other verbs whose *Taw* of *Hitpa!el* coalesces with the first letter of the radical;

e.g. *HiNaBé* (הנבא) =(*HiTNaBé* --התנבא);[7]

(D) *H* of *Hitpa!el* when the first radical is *Z* (*Zadi*) (צ) or *Z* (*Zayin*) (ז) and the *Taw* (ת) is mutated to a *Tet* (ט) or *Dalet* (ד)and transposed;

e.g. *HiZTaDéQ* (הצטדק), *HiZDaMéN* (הזדמן);

(N) *M* (*Mem*) (מ) of the participle of *Pi!el*, *Pu!al*, *Hif!il* and *Hof!al*;

(N) *M* (*Mem*) (מ) of *Hitpa!el* with transpoition of *Taw* (ת)

---

[6] The characters in parentheses represent the original letter of the affixes according to the computer transliteration. *Vide* Introduction.

[7] Those exceptions have been categorized as such in the verb classification.

in verbs whose first radical is S (ס) or S (ש),

e.g. MiSTaDéR (מסתדר), MiŠTaMéR (משתמר);

(N) M (Mem) (מ) of the participle Hitpa!el with the coalesced Taw (ת) in verbs whose first radical is D (Dalet) (ד), Ṭ (Ṭet) (ט) or T (Taw) (ת),

e.g. MiDaBéR (מדבר) = (MiTDaBéR--מתדבר);

MiṬaHéR (מטהר) = (MiTṬaHéR--מתטהר);

MiTaMéM (מתמם) = (MiTṬaMéM--מתטמם);

and the exceptions of other verbs whose Taw (ת) of Hitpa!el coalesces with the first letter of the radical,

e.g. MiNaBé (מנבא) = (MiTNaBé-מתנבא);

(N) M (Mem) (מ) of Hitpa!el when the first radical is Z (Zadi) (צ) or Z (Zayin) (ז) and the Taw (ת) is mutated to a Ṭet (ט) or Dalet (ד) and transposed,

e.g. MiZṬaDéK (מצטדק);

MiZDaMéM (מזדמן);

(P) N (Nun) (נ) of Nif!al;

(ZD) HT (He Taw) (הת) of Hitpa!el in the perfect;

(ZN) MT (Mem Taw) (מת) of the participle of Hitpa!el;

(0ZIΘ) 'YTN (EYTaN) (איתן) of the imperfect of Hitpa!el together with the Taw (ת) of Hitpa!el;

(ZP) NT (Nun Taw) (נת) of Nitpa!el--the Aramaic equivalent[8] of Hitpa!el of the perfect adapted in Hebrew.

---

[8] The semantic differences of opinion to which certain grammarians subscribe are of no importance here.

Suffixes--Verbs (Table C)[9]

In treating the suffixes I have been guided in a preliminary fashion by the classification adopted by Meir Šapiro and Ya!akov Choueka[10] which logically embraces suffixes which govern adjuncts and that of suffixes which do not. However, I have rejected the phonetic criterion the author's have employed in their classification.

The coalescence of the third radical with the suffix poses a problem of classification. The resultant disappearance in this case of a letter introduces the problem of whether to classify the compensatory *dageš forte* as the final radical or as a suffix letter. The authors' view considers the *dageš* as replacing rather the first letters of the suffix. This has merit for it conserves the integrity of the radical and hence effects an economy in arrangement of stems. However, the number of radicals involved in this type of change is very little, and since this project is not oriented in stem dictionaries, the economy spoken of is of no value.

On the other hand it increases the number of suffixes unnecessarily. To illustrate--considering a *Lamed Taw* (לת) verb, e.g. *KaRaT* (כרת), in the analysis of the 2nd person, plural, perfect, the authors, because of the coalescence of the *Taw* (ת)

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[9] *Vide* Table C.

[10] *LeŠoNéNu*, *op. cit.* p. 358.

of *Tem* (תם) and *Ten* (תן) into the final *Taw* (ת) of *KaRaT* (כרת) in *KaRaTeM* (כרתם), would find it necessary to add two additional listings in the table of pronominal suffixes, namely *M* (*Mem*) (ם) and *N* (*Nun*) (ן). This is obviated in case of my system since I consider the *dageš forte* as compensatory for the final *Taw* (ת) and therefore in virtue retaining the original *Taw* (ת) of the suffixes.

The classification of the suffixes which I employ represents a further virtue of my system of analysis in that it imposes a consistency which excludes exceptions and effects greater order and clarity, all of which benefit the treatment of the material.

In sum, I found it advisable to consider the *dageš* as replacement for the final radical in keeping with the traditional grammarians (so it seems to me). There is thus not only conserved the economy of the suffixes, but there is also introduced a consistency of form which tends to enhance the validity of conclusions.

The following is a discussion of suffixes which do not govern adjuncts: The null entry of Table C indicates absence of a suffixal attachment to the verb stem. A positive marking in the null row (/) therefore indicates the possibility of independent existence of verbs and nouns or legitimacy of direct attachment of the pronominal suffix to the verb stem. A negative marking (0) would, of course, indicate the contrary.

Listing of Suffixes in Table C

(D) 2H[11] of the perfect, secon person, feminine, singular;

e.g. QaŠṬaH (קשטה);

(D2) 2H of the active participle, first, second and third person, feminine, singular;

e.g. QoŠṬaH (קושטה);

(D) H-cohortative (the lengthened form) of the first person of the imperfect, singular and plural;

e.g. "aSuRa[12] (אסורה), 'QŠṬaH (אקשטה), NiQŠṬaH (נקשטה);

same in the imperative, second person, masculine, singular;

e.g. QeŠaṬaH (קשטה);

(E) W (Suruk) of the perfect, third person, plural, masculine, and feminine;

e.g. QaŠṬu (קשטו);

(E) W (Suruk) of the imperfect, second and third person, masculine, plural;

e.g. TiQŠṬu (תקשטו), YiQŠṬu (יקשטו);

same for the imperative, second person, masculine, plural;

e.g. QiŠṬu (קשטו);

(I) Y (Yud) of the imperfect, second person, feminine, singular;

e.g. TiQŠṬi (תקשטי);

same as in the imperative, second person, feminine, singular;

e.g. QiŠṬi (קשטי);

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[11] This H is marked 2H to differentiate between it and the cohortative H.

[12] Exodus 3:3: "I will turn aside now."

(Z) T (Taw) of the perfect, second person, masculine and feminine, singular;

e.g. QaŠaṬTa (קשטת), QaŠaṬT (קשטת);

(Z) T (Taw) of the active participle, first, second and third person, feminine, singular;

e.g. QoŠeṬeT (קושטת);

(Z) T (Taw) of the infinitive construct of the Pe Yud (פ-י) verbs;

e.g. (YŠV - ישב) ŠeVeT (שבת);

(ZE) WT (Waw Taw) (ות) of the active participle, first, second and third person, feminine, plural;

e.g. QWŠṬWT (QoŠṬoT) (קושטות);

(ZE) WT (Waw Taw) (ות) of the infinitive of Lamed He (ל-ה) verbs;

e.g. the infinitive of the radical QNH, LQNWT (LiQNoT) (לקנות);

(MI) YM (Yud Mem) (ים) of the active participle, first and second person, masculine, plural;

e.g. QWŠṬYM (QoŠṬiM)(קושטים);

(0I) YN (Yud Nun) (ין) the Aramaic counterpart of YM adapted in Hebrew;

(DP) NH (Nun He) (נה) of the imperfect, second and third person, feminine, plural;

e.g. TQŠṬNH (TiQŠoṬNaH) (תקשטנה);

(DP) NH (Nun He) (נה) of the imperative, second person, feminine, plural;

e.g. QŠṬNH (QeŠoṬNaH) (קשטנה);

(EP) NW (Nun Suruq) (נו) of the perfect first person, masculine and feminine, plural;

e.g. QŠṬNW (QaŠaṬNu) (קשטנו);

(IP) NY (Nun Yud) of the present participle, first person, singular;

e.g. DWMNY (DoMaNi) (דומני), SBWRNY (SVuRaNi) (סבורני);

(IZ) TY (Taw Yud) (תי) of the perfect first person, masculine and feminine, singular;

e.g. QŠṬTY (QaŠaṬTi)(קשטתי);

(MZ) TM (Taw Mem) (תם) of the perfect, second person, masculine, plural;

e.g. QŠṬTM (QeŠaṬTeM)(קשטתם);

(0Z) TN (Taw Nun) (תן) of the perfect, second person, feminine, plural;

e.g. QŠṬTN (QĕŠaṬTeN) (קשטתן).

Suffixes Which Govern Pronominal Affixes[13] (Table C1)

Since not all suffixes govern pronominal affixes, it was necessary to prepare an additional table listing those suffixes which do so. In the course of the affix-splitting[14] process, the computer must determine whether a given pronominal affix may be attached to a given suffix. This purpose as well is one which is served by this table. This is immediately apparent by the strikingly large vacant area (0) in the proper place of Table C in contrast with the equally large marked area (/) for its counterpart in Table Cl. Table Cl necessarily would be limited to the active voice since the verbs tested govern accusatives. For example, in Table C the T (Taw) (ת) of the perfect and the participle is indicated (/) in all seven constructions and in Table Cl the same T (Taw) (ת) is indicated (/) only in the active constructions. This is because a pronominal suffix may appear only in those constructions. The numerous positive (/) markings for the null row of Table Cl, as well as in Table C, of course, indicate the generality of the independent occurrence without affixed suffixes of all the grammatical categories there listed. It is apparent then, that a pronominal affix may also be attached directly to the verb or noun, without necessary intermediation of a suffixal adjunct.

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[13] All possible pronominal affixes adjoined to each of these suffixes may be found in Table D.

[14] See Chapter III.

The interpretation of the null row under the listings of person, number, and gender, in the pronominal columns of Table Cl is readily made. (/) indicates that the pronominal affix may occur independently attached to the verb stem, e.g. QŠṬW (QĕŠaṬo) (קשטו) which is equivalent to QaŠaṬ 'oTo (קשט אותו).

Listing of Suffixes in Table Cl

(E) W (Šuruq) (ו) of the perfect, third person, plural;

e.g. QŠṬWHW (QiŠṬuHu) (קשטוהו);

(E) W (Šuruq) (ו) same as above, of the imperfect, third person, masculine, plural;

e.g. YQŠṬWHW (YiQŠeṬuHu) (יקשטוהו);

(E) W (Šuruq) (ו) of the imperative, second person, masculine, plural;

e.g. QŠṬWHW (QiŠṬuHu) (קשטוהו);

(I) Y (Yud) (י) of the imperfect, second person, feminine, singular;

e.g. TQŠṬYHW (TiQŠěṬiHu)(תקשטיהו);

(Z) T (Taw) (ת) of the perfect, second person, feminine, singular;

e.g. QŠṬT (QaŠaṬT)(קשטת);

(Z) T (Taw) (ת) of the perfect, third person, singular, feminine, replacing the normal suffixal Hé (ה) when governing a pronominal;

e.g. QŠṬH (QaŠṬaH) (קשטה), QŠṬTNY (QěŠaṬaTNi)(קשטתני),
QSTTK (QěŠaṬaTKa) (קשטתך), etc. in all persons;

(Z) T (Taw) (ת) of the participle, first, second and third person, feminine, singular;

e.g. QWŠṬT (QoŠeṬeT)(קושטת);

(ZE) WT (Waw Taw) (ות) of the participle, first, second and third person, feminine, plural;

e.g. QŠṬWT (QoŠṬoT) (קשטות);

(EP) NW (Nun Šuruq) (נו) of the perfect, first person, plural;

e.g. QŠṬNW (QaŠaṬNu) (קשטנו);

(IZ) TY (Taw Yud) (תי) of the perfect, first person, singular;

e.g. QŠṬTY (QaŠaṬTi) (קשטתי).

TW (Taw Šuruq) (תו) as in QŠṬTWNY (QeŠaṬTuNi) (קשטתוני) was not entered as a suffix in our classification. Rather WNI (וני) was entered as a pronominal affix. The affix-splitting in this case would then be QŠṬ-T-WNY, not QŠṬ-TW-NY, contrary to the suggestion made in LĕŠoNéNu.[15] This again is a result of the above mentioned decision to keep the suffixes constant.

Pronominal Affixes (Table D)

The pronominal affixes consist of objective pronouns affixed to verbs, and the possessive pronouns attached to nouns. The listings of person, number and gender in the verbal columns (15 through 21) refer to the subject of the verb; person, number and gender in the pronominal columns (28 through 34) refer to the object of the verb. It may seem somewhat paradoxical that in those cases where the verbal categories are consistently null (i.e. the null row is marked /) the pronominal columns should as consistently take a contrary grading (i.e.

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[15] op. cit.

the null row is marked 0). The (/) grading in the null row for the verbal categories presents no difficulty since the meaning is clear, i.e. these categories can exist independently without the need to govern an affix. The matter of gradings for the pronominal columns is not so obvious. The explanation lies in the fact that the pronominal columns represent essentially particularizations of the generalizations indicated by the affixes listed. The grading in effect responds to the question: "Does the particularization exist or not?" Therefore it is meaningless to speak of particulars when the general is absent (null). The mark is thus (0).

Affixes of Nouns

The assimilation of auxilary elements with nouns is a relatively simple matter. The combinations and usages herein pertaining, however, vary as much with the type of literature as in the case of verbs.

Prefixes are irrelevant to nouns. This fact was of considerable utility in the various operations connected with this study, as illustrated in Chapter III.[16]

The possessives are naturally included in the pronominal affixes. In the column of the pronominal affixes (28 through 34) the person, gender and number of the given pronoun are indicated.

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16. See p.33 "Checking Validity of Combinations."

The nature of the gender and number listing in the noun columns is immaterial with respect to the pronominal affix tested. A possessive such as the Waw (ו) of ŠLW (ŠeLo)(שלו) may be indifferently attached either to a masculine noun, e.g. DWD, DWDW (DoD, DoDo) (דוד , דודו) or to a feminine noun, e.g. 'VN, 'VNW (EVeN, AVNo) (אבן, אבנו). The column of nouns in the absolute state, Table D, column 27, is consistently marked (0). The reason is obvious. A noun in the absolute state cannot be adjoined to an affix.

The following are taken as the substantive suffixes:

(D) H (Hé) (ה) Locale--(locative accusative);

e.g. 'RZH (ARZaH) (ארצה), QDYMH (QaDiMaH) (קדימה);

(2D) 2H (2 Hé) (ה) tone-bearing (Qamaz) Hé (ה);

e.g. YLD, YLDH (YeLeD, YaLDaH) (ילד , ילדה);

(I) Y (Yud) (י) of construct state;

e.g. BNY (BeNeY) (בני), 'VNY, (AVNeY) (אבני);

(Z) T (Taw) (ת) of construct state;

e.g. TWRT (ToRaT) (תורת);

(TE) WT (Waw Taw) (ות) plural, masculine and feminine;

e.g. 'VWT (AVoT) (אבות), BNWT (BaNoT) (בנות);

(MI) YM (Yud Mem) (ים), plural, masculine;

e.g. BNYM (BaNiM)(בנים);

(NI) YN (Yud Nun) (ין) Aramaic plural adopted in Hebrew;

e.g. BNYN (BNiN) (בנין); DKRYN (DiKRiN) (דכרין);

(ZI) YT (Yud Taw) (ית) singular feminine, characterized by final YT (ית);

e.g. QPDNYT (QaPDaNiT) (קפדנית);

(ZE⊕) 'WT (Alef Waw Taw) (אות) Mishnaic plural, especially for nouns of Greek and Latin etymology;

e.g. T'ṬR'WT (TeaṬRa'oT) (תאטראות);

(MI⊕) 'YM (Alef Yud Mem) (אים) masculine plural formed by final 'YM (אים);

e.g. HG'YM (HaGaiM) (הגאים).

The Passive Participle

In all five tables the passive participle (פעול) columns 35 through 36 have been checked against affix entries and marked accordingly, both for absolute and construct forms; e.g. QŠWṬ (QaŠuṬ) (קשוט), QŠWṬYNW, (QĕŠuṬéNu) (קשוטינו).

CORRELATION OF AFFIXES AGAINST GRAMMATICAL CATEGORIES

TABLE A

Auxilary Elements			Verbs																					Nouns						Pronominals							P.P.	
			Perf.	Part.	Imp.	Imper.	Inf.	" Con.	" Abs.	Hif.	Pi.	Pa.	Hof.	Pu.	Nif.	Hit.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	Fem.	Masc.	Pl.	Sing.	Con.	Abs.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	P.P.	P.P.Pr.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
null			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
A		ב					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C		ד	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D		ה	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D 2	2	ה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
E		ו	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
K		כ		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
L		ל		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
N		מ		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Y		ש	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D C	ה	ד		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
A D	ב	ה					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
K D	כ	ה					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
L D	ל	ה					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
N D	מ	ה					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
A E	ב	ו					/	/	/	/	/				/	/														/	/	/	/	/	/	/	/	/
D E	ה	ו	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
2 D E	2 ה	ו		/						/	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
K E	כ	ו		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
L E	ל	ו		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
N E	מ	ו		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Y E	ש	ו	/	/	/					/	/	/	/	/	/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
A K	ב	כ		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C K	ד	כ	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/															
L K	ל	כ					/	/		/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/		
N K	מ	כ					/	/		/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Y K	ש	כ	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C N	ד	מ	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/															
D N	ה	מ		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
L N	ל	מ					/	/	/	/	/	/	/	/	/	/														/	/	/	/	/	/			

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Table A (continued)

Auxilary Elements		Verbs																					Nouns						Pronominals							P.P.	
		Perf.	Part.	Imp.	Imper.	Inf.	" Con.	" Abs.	Hif.	Pi.	Pa.	Hof.	Pu.	Nif.	Hit.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	Fem.	Masc.	Pl.	Sing.	Con.	Abs.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	P.P.	P.P.Pr.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Y N	מש	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/							/	/	/	/	/	/	/		
A Y	שב					/	/	/	/	/	/	/	/	/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D Y	שה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
L Y	של					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
N Y	שמ					/	/	/	/	/	/			/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
L K D	הכל					/	/	/	/	/	/			/	/																						
Y K D	הכש	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
D N D	המה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/				/	/	/	/	/	/
L N D	המל					/	/		/	/	/			/	/																						
Y N D	המש	/		/					/	/	/	/	/	/	/	/	/	/	/	/	/	/							/	/	/	/	/	/	/		
A K E	רכב																						/	/	/	/	/	/	/	/	/	/	/	/	/		
N K E	רכמ																						/	/	/	/	/	/	/	/	/	/	/	/	/		
Y K E	רכש	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
Y N E	רמש	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D N K	כמה																						/	/	/	/		/									
A Y K	כשב																						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D Y K	כשה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
L Y K	כשל																						/	/	/	/	/	/	/	/	/	/	/	/	/		
N Y K	כשמ																						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Y K L	לכש	/		/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
D Y N	משה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
Y K Y	שכש	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
L N Y	שמל					/	/	/	/	/	/			/	/																						
Y N Y	שמש	/		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
A Y K E	רכשב																						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
N Y K E	רכשמ																						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Y K L E	רלכש	/		/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
D N Y K	כשמה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/									/
Y K L Y	שלכש			/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	
D N Y K E	רכשמה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/		/

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Table A (continued)

Auxilary Elements		Verbs																					Nouns						Pronominals							P.P.	
		Perf.	Part.	Imp.	Imper.	Inf.	" Con.	" Abs.	Hif.	Pi.	Pa.	Hof.	Pu.	Nif.	Hit.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	Fem.	Masc.	Pl.	Sing.	Con.	Abs.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	P.P.	P.P.Pr.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
DNYKL	לכשמה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/		/
DNYKLE	רלכשמה		/						/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/		/

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TABLE B

Prefixes		Verbs																					Nouns						Pronominals							P.P.	
		Perf.	Part.	Imp.	Imper.	Inf.	" Con.	" Abs.	Hif.	Pi.	Pa.	Hof.	Pu.	Nif.	Hit.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	Fem.	Masc.	Pl.	Sing.	Con.	Abs.	3rd P.	2nd P.	1st P.	Fem.	Masc.	Pl.	Sing.	P.P.	P.P.Pr.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
null		/	/		/	/	/	/		/	/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Θ	א			/					/	/	/	/	/	/	/			/	/	/		/							/	/		/	/	/	/		
D	ה	/			/	/	/	/	/			/		/	/	/	/	/	/	/	/	/							/	/	/	/	/	/	/		
I	י			/					/	/	/	/	/	/	/	/				/	/	/							/	/	/	/	/	/	/		
N	מ		/						/	/		/	/		/	/	/	/	/	/	/	/							/	/	/	/	/	/	/		
P	נ	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/							/	/		/	/	/	/		
Z	ת			/					/	/	/	/	/	/	/	/	/		/	/	/	/							/	/	/	/	/	/	/		
Z Θ	את			/											/			/	/	/		/															
Z D	הת	/			/	/	/	/							/	/	/	/	/	/	/	/															
Z I	ית			/											/	/				/	/	/															
Z N	מת		/												/	/	/	/	/	/	/	/															
Z P	נת	/													/	/	/	/	/	/	/	/															
2 Z P 2	נת			/												/		/	/	/	/																
Z Z	תת			/												/	/	/	/	/	/	/															

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CORRELATION OF AFFIXES AGAINST GRAMMATICAL CATEGORIES

TABLE C

Suffixes			Verbs																					Nouns						Pronominals							P.P.	
			1 Perf.	2 Part.	3 Imp.	4 Imper.	5 Inf.	6 " Con.	7 " Abs.	8 Hif.	9 Pi.	10 Pa.	11 Hof.	12 Pu.	13 Nif.	14 Hit.	15 3rd P.	16 2nd P.	17 1st P.	18 Fem.	19 Masc.	20 Pl.	21 Sing.	22 Fem.	23 Masc.	24 Pl.	25 Sing.	26 Con.	27 Abs.	28 3rd P.	29 2nd P.	30 1st P.	31 Fem.	32 Masc.	33 Pl.	34 Sing.	35 P.P.	36 P.P.Pr.
	null		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	D	ה			/	/	/				/	/				/		/	/	/	/	/	/	/	/		/		/									
	2 D	2 ה	/	/						/	/	/	/	/	/	/	/	/	/	/			/	/			/		/									/
	E	ו	/		/	/				/	/	/	/	/	/	/	/	/		/	/	/																
	I	י			/	/				/	/	/	/	/	/	/		/		/			/	/	/	/		/									/	
	M	ם																						/	/	/			/									
	Ø	ן																						/	/	/			/									
	Z	ת	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/			/	/	/									
	Z E	ות		/			/	/	/	/	/	/	/	/	/	/	/	/	/	/		/		/	/	/		/	/								/	/
	M I	ים		/						/	/	/	/	/	/	/	/	/	/		/	/		/	/	/			/									/
	Ø I	ין		/						/	/	/	/	/	/	/	/	/	/		/	/		/	/	/			/									/
	Z I	ית																						/			/	/	/									
	D P	כה			/	/				/	/	/	/	/	/	/	/	/		/		/																
	E P	כו	/							/	/	/	/	/	/	/		/	/	/	/	/																
	I P	כי		/															/	/	/		/															/
	I Z	תי	/							/	/	/	/	/	/	/			/	/	/		/															
	M Z	תם	/							/	/	/	/	/	/	/		/			/	/																
	Ø Z	תן	/							/	/	/	/	/	/	/		/		/		/																
	Z E Θ	אות																						/	/	/		/	/									
	M I Θ	אים																							/	/			/									
	Z E I	יות																						/	/	/		/	/									

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CORRELATION OF AFFIXES AGAINST GRAMMATICAL CATEGORIES

TABLE C1

Suf. Gov. Pron.	Verbs																					Nouns						Pronominals							P.P.	
	1 Perf.	2 Part.	3 Imp.	4 Imper.	5 Inf.	6 " Con.	7 " Abs.	8 Hif.	9 Pi.	10 Pa.	11 Hof.	12 Pu.	13 Nif.	14 Hit.	15 3rd P.	16 2nd P.	17 1st P.	18 Fem.	19 Masc.	20 Pl.	21 Sing.	22 Fem.	23 Masc.	24 Pl.	25 Sing.	26 Con.	27 Abs.	28 3rd P.	29 2nd P.	30 1st P.	31 Fem.	32 Masc.	33 Pl.	34 Sing.	35 P.P.	36 P.P.Pr.
null	/	/	/	/	/	/	/	/	/	/					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
E ו	/		/	/				/	/	/					/	/		/	/	/								/	/	/	/	/	/	/		
I י			/	/				/	/	/						/		/			/							/		/	/	/	/	/		
Z ת	/	/						/	/	/					/	/	/	/	/	/	/	/			/	/		/	/	/	/	/	/	/	/	
Z E ה ו		/						/	/	/					/	/	/	/	/	/		/	/	/		/		/	/	/	/	/	/	/	/	
E P ו נ	/							/	/	/							/	/	/	/								/	/	/	/	/	/	/		
I Z י ת	/							/	/	/							/	/	/		/							/	/	/	/	/	/	/		

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CORRELATION OF AFFIXES AGAINST GRAMMATICAL CATEGORIES

TABLE D

Pronominal Affixes			Verbs																					Nouns						Pronominals							P.P.	
			1 Perf.	2 Part.	3 Imp.	4 Imper.	5 Inf.	6 " Con.	7 " Abs.	8 Hif.	9 Pi.	10 Pa.	11 Hof.	12 Pu.	13 Nif.	14 Hit.	15 3rd P.	16 2nd P.	17 1st P.	18 Fem.	19 Masc.	20 Pl.	21 Sing.	22 Fem.	23 Masc.	24 Pl.	25 Sing.	26 Con.	27 Abs.	28 3rd P.	29 2nd P.	30 1st P.	31 Fem.	32 Masc.	33 Pl.	34 Sing.	35 P.P.	36 P.P.Pr.
null			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/									/
D		ה	/	/	/	/	/	/		/	/	/					/	/	/	/	/	/	/	/	/		/	/		/			/			/	/	
E		ו	/	/	/		/	/		/	/	/					/	/	/	/	/		/	/	/		/	/		/				/		/	/	
I		י					/	/		/	/	/			/	/								/	/	/	/	/				/	/	/		/	/	
J		ך	/	/	/		/	/		/	/	/					/		/	/	/	/	/	/	/		/	/			/		/	/		/	/	
M		ם	/	/	/	/	/	/		/	/	/					/	/	/	/	/	/	/	/	/		/	/		/				/	/		/	
Ø		ן	/	/	/	/	/	/		/	/	/					/	/	/	/	/	/	/	/	/		/	/		/			/		/		/	
E D		הו	/	/	/	/	/	/		/	/	/					/	/	/	/	/	/	/							/				/		/		
D E		וה	/							/	/	/						/		/	/	/								/			/			/		
M E		ום	/							/	/	/						/		/	/	/								/				/	/			
Ø E		ון	/							/	/	/						/		/	/	/								/			/	/	/			
D I		יה	/							/	/	/						/		/			/	/	/	/		/		/			/			/	/	
E I		יו	/							/	/	/						/		/			/	/	/	/		/		/				/		/	/	
J I		יך	/							/	/	/							/	/	/		/	/	/	/		/			/		/	/		/	/	
M I		ים	/			/				/	/	/						/	/	/	/		/								/			/	/			
Ø I		ין	/			/				/	/	/						/	/	/	/		/								/		/	/	/			
M K		כם	/	/	/		/	/		/	/	/					/		/	/	/	/	/	/	/		/	/			/			/	/		/	
Ø K		כן	/	/	/		/	/		/	/	/					/		/	/	/	/	/	/	/		/	/			/		/		/		/	
D P		נה			/					/	/	/					/	/	/	/	/		/							/			/			/		
2 D P	2	נה			/					/	/	/							/	/	/	/								/			/			/		
3 D P	3	נה				/				/	/	/						/			/		/							/			/			/		
E P		נו	/	/	/	/				/	/	/					/	/		/	/	/	/	/	/		/	/				/	/	/	/		/	
I P		ני	/	/	/	/	/	/		/	/	/					/			/	/	/	/									/	/	/		/		
E D E	ו	וה	/							/	/	/						/		/	/	/								/				/		/		
E P E	ו	ונ	/							/	/	/						/		/	/	/										/	/	/	/			
I P E	י	ונ	/							/	/	/						/		/	/	/										/	/	/		/		
E D I	ו	יה	/							/	/	/						/		/			/							/				/		/		
M D I	ם	יה																						/	/	/		/		/				/	/		/	
Ø D I	ן	יה																						/	/	/		/		/			/		/		/	

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Table D (continued)

Pronominal Affixes		Verbs																					Nouns						Pronominals							P.P.	
		Perf. 1	Part. 2	Imp. 3	Imper. 4	Inf. 5	" Con. 6	" Abs. 7	Hif. 8	Pi. 9	Pa. 10	Hof. 11	Pu. 12	Nif. 13	Hit. 14	3rd P. 15	2nd P. 16	1st P. 17	Fem. 18	Masc. 19	Pl. 20	Sing. 21	Fem. 22	Masc. 23	Pl. 24	Sing. 25	Con. 26	Abs. 27	3rd P. 28	2nd P. 29	1st 30	Fem. 31	Masc. 32	Pl. 33	Sing. 34	P.P. 35	P.P.Pr. 36
MKI	יכם																						/	/	/		/			/			/	/		/	
ØKI	יכן																						/	/	/		/			/		/		/		/	
EPI	ינו	/		/	/	/	/		/	/	/						/		/	/		/	/	/	/		/				/	/	/	/		/	
IPI	יני	/	/	/	/	/	/		/	/	/						/		/	/		/									/	/	/		/		

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CHAPTER III

THE COMPUTER AND HEBREW MORPHOLOGY

Assembly and Rejection Process

Understandably, in order to identify the root or basic form of a given verb or noun we must draw on whatever related lexicographical and grammatical knowledge we may have. To endow the computer with capacity for stem recognition presupposes its preliminary endowment with our own knowledge in this respect.

For example, the initial step in examining the word B!YNK (Bĕ!éNeKa) (בעיניך), is to determine the combination of its various, possible components. The Y and K (Yud and Kaf) may be the possessive pronoun (yours), but they may also be part of a noun, as in BZYK (BaZiK) (בזיך). We know, however, that no noun B!YNK (Bĕ!éNeKa) (בעיניך) exists. Similarly, !YNK (!éNeKa) (עיניך) is eliminated, recognizing B (ב) as a preposition. Also for B!YNY (Bĕ!éneY) (בעיני), recognizing the possessive K (ך), and for !YNY . (!eYNé) (עיני) discounting the affixes, B and K. Thus the YK is affixed to the noun !aYiN (עין) as the plural possessive pronoun, and the B (ב) as a preposition.

This is the process of human reasoning. The computer must function in an analogous manner. It must respond to the purely morphological aspect of the word analyzed by evoking all the possible, grammatical implications of this morphology.

This process was first used for mechanical analyzation of Russian inflected forms. It was described as "'affix-splitting' and consists of matching the end of a referred word against a list of recognized affixes having grammatical significance."[1] In the case of the Hebrew language, affixes are attached both at the beginning and the end of a word. An exhaustive[2] compilation of auxilary elements, prefixes, suffixes, and pronominal affixes is presented together with their functional roles.[3] The computer's initial task having been completed, there arises the problem of the methodical elimination of the irrelevant, mechanical fractionations produced by the instrument. The continuing process must follow the path taken by the human agent, assembly and rejection on the basis of grammar, and then assembly and rejection on the basis of lexicography.

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1. J. McDaniel and S. Whelan, "The Grammatical Interpretation of Russian Inflected Forms Using A Stem Dictionary," National Physical Laboratory, Teddington, England, Proceedings of the 1961 International Conference on Machine Translation Applied Language Analysis, 1961, pp. 364-378.

2. Not precisely. Vid. footnote 5, Chapter II.

3. Vid. Tables.

Fractionation of the Tested Word

The illustration which follows should demonstrate clearly the underlying functions of the computer; namely the mechanical affix-splitting of the material studied, and selection of meaningful combinations of the various fractionations. The word MiTLuNoT, vowel-less MTLWNWT, transliterated ZEPELZN[4] was fed into the computer. Besides the word itself as an intact unit, fourteen combinations were produced.

Although the illustration given involves minimally a triliteral stem, it must be cautioned at this point that the computer is not restricted thereby, but in its functioning will in general produce biliteral and even monoliteral stems. Lĕsonénu's[5] suggestion that monoliteral stems be omitted was not accepted. The authors maintain that "exceptions are only Pé-Nun-Lamed-Hé (פ"נ - ל"ה) verbs in constructions Hif!il, Huf!al, and the imperfect of Pa!al. But there are only five such verbs: NZH, NṬH, NZH, NKH, NŠH (נזה , נטה, נצה, נכה, נשה) and each such verb possesses only seven diverse forms of a monoliteral stem; HKW[6], HKY, TKY, TKW, YKW, MKYM, MKWT (הכו,[6] הכי, תכי, תכו, יכו, מכים , מכות). That is to say: In total there are 35 forms, and with these it is possible to deal individually." [5]

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[4] The machine has done the reversing of characters left to right; see introduction.

[5] Y. Cheouka and M. Šapiro, Lĕsonénu, op. cit. p. 361.

[6] HKW has been omitted from the article, apparently through an oversight.

We know, however, that more of this type exist. For example, the Pa!al of verbs whose radicals end in YT (ית) e.g. ḤYT (חית), ḤTY (ḤaTi) (חתי) or in WT (ות) e.g. MWT (מות), MTY (MaTi) (מתי) etc., and the perfect (except for the first and third person) plural of verbs, the radicals of which end in TT (תת), e.g. KTT (כתת), in Hif!il, HKTY (HiKiTi) (הכתי), etc.

True that Lĕšonénu is self-consistent. The number of verb stems in accordance with their view, remains constant since the final radical is retained in the correct fractionation. My system, however, demands the shifting of the final radical for the purpose of retaining the integrity and constancy of the suffixes, therefore adding to the number of monoliteral stems. Thus while the first person, singular, perfect of MWT (מות), MTY (MaTi) (מתי) would be fractioned by Lĕšonénu into MT-Y, the system here employed would give M-TY retaining the full suffix. Nevertheless, it seems to be superfluous to make the suggested ommissions. The computer which functions on the basis of the listed affixes necessarily is limited in its choice of stem fractionation. As the illustration demonstrates, the minimal number of letters in the stem are three. The number of verbs that would perforce be reduced to a single lettered stem are thus kept to a minimum. Consideration of devising a table for monoliteral verbs was therefore dismissed.

Computer Affix-Splitting Based on Tables of Affixes

P.A.	Suffix	Stem	Prefix	A.E.		
		ZEPELZ	N		ZEPELZN	1.
		ZEPELZ		N	ZEPELZN	2.
		ZEPEL	ZN		ZEPELZN	3.
		ZEPEL	Z	N	ZEPELZN	4.
	ZE	PELZN			ZEPELZN	5.
	ZE	PELZ			ZEPELZN	6.
	ZE	PELZ		N	ZEPELZN	7.
	ZE	PEL	ZN		ZEPELZN	8.
	ZE	PEL	Z	N	ZEPELZN	9.
	Z	EPELZN			ZEPELZN	10.
	Z	EPELZ	N		ZEPELZN	11.
	Z	EPELZ		N	ZEPELZN	12.
	Z	EPEL	ZN		ZEPELZN	13.
	Z	EPEL	Z	N	ZEPELZN	14.

The application of a pertinent, operational rule was to lead to the subsequent rejection of three of these combinations by the computer, namely numbers 4, 9 and 14. The eleven remaining combinations could not be disqualified at this stage by grammatical criteria, since they are grammatically legitimate combinations. Each represents a recognized linguistic form either as a verb and/or noun.

The Legitimate Combinations

	P.A.	Suffix	Stem	Prefix	A.E.	Sample of Corresponding Recognized Form
1.			ZEPELZ	N		TBRT M (מתרבת)[7]
2.			ZEPELZ		N	TWNṬQ M (מקטנות)
3.			ZEPEL	ZN		TWBR TM (מתרבות)[8]
5.		ZE	PELZN			TW !WZQM (מקצועות)
6.		ZE	PELZ	N		TW SNRFM (מפרנסות)
7.		ZE	PELZ		N	TW !WZQM M (ממקצועות)
8.		ZE	PEL	ZN		TW ṬŠQ TM (מתקשטות)
10.		Z	EPELZN			T ṬŠWQ (קושטת)
11.		Z	EPELZ	N		T QBD M (מדבקת)
12.		Z	EPELZ		N	T SNRFM M (ממפרנסת)
13.		Z	EPEL	ZN		T SNRP TM (מתפרנסת)

Grammatically Illegitimate Combinations

	P.A.	Suffix	Stem	Prefix	A.E.
4.			ZEPEL	Z	N
9.		ZE	PEL	Z	N
14.		Z	EPEL	Z	N

Checking Validity of Combinations

Specially designed tables[9] served as the basis which permitted the computer to determine the rejection of the disqualified combinations. Their rationale expressed itself in correlating the various affixes with grammatical categories. Legitimate correlations are designated X; those not so, are marked 0.[10] In addition, an independent null row is indicated. Any verb or noun, whether inflected or not, may of course, occur without any auxilary element, but it is impossible for the infinitive, perfect, or participle of the constructions of the Nif!al, Hif!il and Hitpa!él to occur without a prefix; nor may the imperfect of a verb occur without the prefixes ÉYTAN. The null row, therefore, indicates whether a given category may exist independently of affix elements.

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[7] MĕTaRBéT (- MŏDaBĕR)

[8] RBH (verb) - MiTRaBoT

[9] See pages 20-27

One hundred thirty-two affixes which are correlated against thirty-six categories were listed. The computer checked each fractionation of a given tested word which has been identified as one of the affixes listed, against the columns of categories; legitimacy was then marked (/). If it was not legitimate, the mark was then (0). There must always be four elements that participate in the combination, namely: auxilary element, prefix, suffix and pronominal affix. This participation may be of a positive or negative nature. The task of the computer is then to decide on the legitimacy of the specific element whether in positive or negative phase. This it does on the basis of the information supplied in the table belonging to the given element. For legitimacy of the positive phase, it consults the row designating the specific affix; for legitimacy of the negative phase, it consults the associated null row.

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[10] In the tables presented in this paper, a diagnal line (/) indicates a positive marking, and a blank, a negative.

A final recording was then drawn by the computer consequent upon defining the status of the four classes of the given combinations resulting from testing the grammatical coherence of the two kinds of prefixes and the two kinds of suffixes. The final recording is represented by that point of the given column corresponding to a particular fractionation-combination, which is now checked by the computer. If an (/) appears at this point, the combination is allowable. If even so much as one component of the tested combination has been graded (0), the relevant point in the column was marked (0).[11] Such a result which does not subscribe to permissability is illustrated above in the case of categories 4, 9 and 14. These were disqualified in the first seven categories of a common verbal nature.[12] Matched against the verbal categories, the T of ĚYTAN, characteristic of the perfect, is incompatible with the prepositional

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[11] See further illustration below of recording by the computer.

[12] See listing of categories in the Tables.

M. The combinations therefore, had no relevancy for the verbal categories in general. They were hence lacking in minimal properties necessary for their inclusion as acceptable combinations. Thus there is exemplified a contribution made by the computer in establishing a basic rule--that which is not relevant to tense and mode cannot be considered a verb.

When matched against the substantive categories, T as a prefix cannot pertain. The entire combination was therefore canceled since neither verb nor noun could be included. Similarly, if the given combination tests (0) against the list of construction categories, or against the categories of person, number and gender, it is outlawed as a verb or noun.

Also the entire combination is invalid if the result of checking a pronominal suffix against the categories of person, number or gender is (0), since a pronominal suffix is necessarily distinguished by person, number and gender.

Application of Empirical Rules

Further rules were applicable at any phase of the computer's functioning inclusive of the correlation of the fractionations against grammatical categories.

Though formal grammar is silent on the matter, it is a linguistic fact that a verb radical cannot excede six letters. A stem in a fractionation which consists evenly of six or greater than six characters therefore has no possibility of being a verb. The first item in the above illustration that was ruled out through the application of this rule exemplifies this case.

A maximum of five obtainable in the quadriliteral roots of the sibilants Z, S, Z, Š (ש, צ, ס, ז) holds only for the Hitpa!el. The first pair of characters (right to left) must then be one of the following: TŠ (שת), TZ (צט), TS (סת), DZ (זד). Otherwise, this combination must also be excluded as a verb. Combinations 3 and 11 of the above illustration were canceled out through the application of this rule.

As we went along, it was possible to introduce empirical rules established on the basis of our observations. For example, the words HWD'WT (HoDa'oT) WHLW'WT (VeHaLVa'oT) (הודאות והלואות) presented an ambiguity to the computer, so that the computer analyzed these as pertaining to verbal categories. It mistook the H (ה) of HWD'WT and HLW'WT (HoDa'oT and HaLVa'oT) (הודאות, הלואות) as being the prefix of Nif!al or Hif!il; the final WT (ות) in both words as belonging to the infinitive of the Lamed Hé (ל"ה) verbs. An empirical rule was therefore devised at this point for guidance of the computer. Since final WT (ות) is applicable in the infinitive only, in the case of verbs of which the final, third letter of the radical is H (ה), the WT (ות) can thus be considered as pertaining to the verbal category only if the preceding stem fractionation consists of two charaters characteristic for Lamed-Hé (ל"ה) verbs only. A combination which included more than two characters in the stem was ruled out as an infinitive form of Hif!il and Nif!al, and therefore as a verb.

In brief, a description has been given of the functioning of the computer. The operation followed four phases. The tested word was first analyzed into legitimate fractions. The number of resulting combinations was further reduced by the application of certain empirical rules derived from grammatical observations. The remaining fractionations were then correlated with the grammatical categories. Finally the valid combinations were then indicated.

```
                                  1
AFFIX SPLITTING BY GIVEN TABLES OF AFFIXES

                    ZE*ELD                        E            ZE+ELDE
                    ZE*EL                         DE           ZE+ELDE
                    ZE*EL     D                   E            ZE+ELDE
          ZE*       ELDE                                       ZE+ELDE
          ZE*       ELD                           E            ZE+ELDE
          ZE*       EL                            DE           ZE+ELDE
          ZE*       EL        D                   E            ZE+ELDE
          ZE        *ELDE                                      ZE+ELDE
          ZE        *ELD                          E            ZE+ELDE
          ZE        *EL                           DE           ZE+ELDE
          ZE        *EL       D                   E            ZE+ELDE
          Z         E*ELDE                                     ZE+ELDE
          Z         E*ELD                         E            ZE+ELDE
          Z         E*EL                          DE           ZE+ELDE
          Z         E*EL      D                   E            ZE+ELDE
```

```
                                  1
AFFIX SPLITTING BY GIVEN TABLES OF AFFIXES

                    ZE*CE     D                       ZE+CED
                    ZE*CE               D             ZE+CED
                    ZE*CE               D2            ZE+CED
          ZE*       CED                               ZE+CED
          ZE*       CE        D                       ZE+CED
          ZE*       CE                  D             ZE+CED
          ZE*       CE                  D2            ZE+CED
          ZE        *CED                              ZE+CED
          ZE        *CE       D                       ZE+CED
          ZE        *CE                 D             ZE+CED
          ZE        *CE                 D2            ZE+CED
          Z         E*CED                             ZE+CED
          Z         E*CE      D                       ZE+CED
          Z         E*CE                D             ZE+CED
          Z         E*CE                D2            ZE+CED
```

Selectric Typing

	ית	תלרגרת		יתלרגרת.
ת		תלרגרת		יתלרגרת.
	מת	לרגרת.		יתלרגרת..
מ	ת	לרגרת		יתלרגרת..
		יתלרג	רת	יתלרגרת
	ית	תלרג	רת	יתלרגרת.
ת		תלרג	רת	יתלרגרת
	ית	ירג	רת	יתלרגרת.
ת	ת	ירג	רת	יתלרגרת.
		יתלרגר	ת	יתלרגרת
	ית	תלרגר	ת	יתלרגרת.
ת		תלרגר	ת	יתלרגרת
	מת	לרגר	ת	יתלרגרת
מ	ת	לרגר	ת	יתלרגרת

Counting from right to left, the first colomn is that of auxiliary elements; the second, of prefixes; the third, of stems; the fourth, of suffixes. Waw Taw (ות) cannot be a pronominal. The fifth column is therefore void.

Recordi

Sample I

The 36 co

So

```
                                                     4
LAZEWNIK PHASE 2 DOUBLES TREATED   AUG.29,1967

  ZEPELZN                                                   ZEPELZ         N
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
PREFIX 2
N           0  1  0  0  0  0  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  0  0
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
---------------------------------------------------------------------------------
            0  1  0  0  0  0  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  0  0

  ZEPELZN                                                   ZEPELZ
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  1
PREFIX 1
N           0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
---------------------------------------------------------------------------------
            0  1  0  0  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  1

  ZEPELZN                                                   ZEPEL          ZN
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
PREFIX 2
ZN          0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  0  0
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
---------------------------------------------------------------------------------
            0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  0  0

  ZEPELZN                                                   ZEPEL          Z
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
PREFIX 2
Z           0  0  1  0  0  0  0  1  1  1  1  1  1  1  1  1  0  1  1  1  1  0  0
PREFIX 1
N           0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
---------------------------------------------------------------------------------
            0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  1  0  1  1  1  1  0  0
```

Recordings by the computer

Sample Illustration of Grammatical Validation by Computer

The 36 columns correspond to the 36 grammatical categories.

Some changes in the data have been entered later.

```
    ZEPELZ          N
1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  0  0  1
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1  1  1  1  1  1  1  C  C  C  C  C  C  1  1  1  1  1  1  1  0  0
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
-----------------------------------------------------------------
1  1  1  1  1  1  1  0  0  C  0  C  C  C  C  C  C  C  0  0  0  0

    ZEPELZ                        N
1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  0  0  1
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1  1  1  1  1  1  1  1  1  C  1  1  1  1  1  1  1  1  1  1  1  1
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
-----------------------------------------------------------------
1  1  1  1  1  1  1  1  1  C  1  1  C  C  C  C  C  C  0  0  0  1

    ZEPEL           ZN
1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  0  0  0  C  0  1
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1  1  1  1  1  1  1  0  0  C  0  C  C  C  C  C  0  0  0  0  0  0
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
-----------------------------------------------------------------
1  1  1  1  1  1  1  0  C  C  0  C  C  C  C  C  0  0  0  0  0  0

    ZEPEL           Z             N
1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  0  0  1
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
1  1  0  1  1  1  1  C  C  C  C  C  C  1  1  1  1  1  1  1  0  0
1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
-----------------------------------------------------------------
1  1  0  1  1  1  1  0  C  C  C  C  C  C  C  C  C  C  0  0  0  0
```

```
                                                      5
LAZEWNIK PHASE 2 DOUBLES TREATED   AUG.29,1967

   ZEPELZN                                   ZE             PELZN
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
ZE          0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  0  1  1
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  1
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  1  0  0  1  1  1  0  1  1  0  1  1  0  1  1  1  1  0  1  0  1  1
   ZEPELZN                                   ZE             PELZ           N
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
ZE          0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  0  1  1
PREFIX 2
N           0  1  0  0  0  0  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  0  0
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  1  0  0  0  0  0  1  1  0  1  1  0  1  1  1  1  1  0  1  0  0  0
   ZEPELZN                                   ZE             PELZ
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
ZE          0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  0  1  1
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  1
PREFIX 1
N           0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  1  0  0  1  1  1  0  1  1  0  1  1  0  1  1  1  1  0  1  0  1  1
   ZEPELZN                                   ZE             PEL            ZN
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
ZE          0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  0  1  1
PREFIX 2
ZN          0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  0  0
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  0  1  0  0  0
```

Sample Illustration of Grammatical Validation by Computer

```
         PELZN
1 1 1 1 1 1 1 1 1 1 1 1 1 C C C C C C 0 0 0 1
1 1 1 1 1 0 1 0 1 1 1 C 1 1 C C C C C 0 0 1 1
0 1 1 1 1 1 1 1 1 1 C 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
----------------------------------------------
0 1 1 1 1 0 1 0 1 1 C C 1 C C C C C C 0 0 0 1
         PELZ          N
1 1 1 1 1 1 1 1 1 1 1 1 1 C C C C C C 0 0 0 1
1 1 1 1 1 0 1 0 1 1 1 C 1 1 C C C C C 0 0 1 1
1 1 1 1 1 1 1 1 0 C C C C C 1 1 1 1 1 1 1 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
----------------------------------------------
1 1 1 1 1 0 1 0 0 0 C C C C C C C C C 0 0 0 0
         PELZ                     N
1 1 1 1 1 1 1 1 1 1 1 1 1 C C C C C C 0 0 0 1
1 1 1 1 1 0 1 0 1 1 1 0 1 1 C C C C C 0 0 1 1
0 1 1 1 1 1 1 1 1 1 C 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
----------------------------------------------
0 1 1 1 1 0 1 0 1 1 C 0 1 C C C 0 0 C 0 0 0 1
         PEL           ZN
1 1 1 1 1 1 1 1 1 1 1 1 1 C C C C C 0 0 0 0 1
1 1 1 1 1 0 1 0 1 1 1 0 1 1 C C C C C 0 0 1 1
1 1 1 1 1 1 1 1 0 0 C 0 C C C C C C C 0 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
----------------------------------------------
1 1 1 1 1 0 1 0 0 0 C 0 C C C C C 0 0 0 0 0 0
```

Sample I

```
LAZEWNIK PHASE 2 DOUBLES TREATED   AUG.29,1967

  ZEPELZN                                    ZE             PEL            Z
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
ZE          0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  0  1  1
PREFIX 2
Z           0  0  1  0  0  0  0  1  1  1  1  1  1  1  1  1  0  1  1  1  1  0  0
PREFIX 1
N           0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  1  0  1  0  1  0  0  0

  ZEPELZN                                    Z              EPELZN
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
Z           1  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  1  0
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  1
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            1  1  0  0  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  0  1  1  0

  ZEPELZN                                    Z              EPELZ          N
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
Z           1  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  1  0
PREFIX 2
N           0  1  0  0  0  0  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  0  0
PRFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  1  0  0  0  0  0  1  1  0  1  1  0  1  1  1  1  1  1  0  1  0  0

  ZEPELZN                                    Z              EPELZ
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
Z           1  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  1  0
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1  1
PREFIX 1
N           0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ---------------------------------------------------------------------
            0  1  0  0  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  0  1  1  0
```

Sample Illustration of Grammatical Validation by Computer

```
          PEL                 Z                   N

1   1   1   1   1   1   1   1   1   1   1   1   1   0   0   0   0   0   0   0   0   0   1
1   1   1   1   1   0   1   0   1   1   1   0   1   1   0   0   0   0   0   0   0   1   1
1   1   1   0   1   1   1   1   0   0   0   0   0   0   1   1   1   1   1   1   1   0   0
1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
-------------------------------------------------------------------------------------------
1   1   1   0   1   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

           EPELZN

1   1   1   1   1   1   1   1   1   1   1   1   1   0   0   0   0   0   0   0   0   0   1
1   1   1   1   1   1   0   1   1   0   0   1   1   1   0   0   0   0   0   0   0   0   0
0   1   1   1   1   1   1   1   1   1   0   1   1   1   1   1   1   1   1   1   1   1   1
1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
-------------------------------------------------------------------------------------------
0   1   1   1   1   1   0   1   1   0   0   1   1   0   0   0   0   0   0   0   0   0   0

           EPELZ                N

1   1   1   1   1   1   1   1   1   1   1   1   1   0   0   0   0   0   0   0   0   0   1
1   1   1   1   1   1   0   1   1   0   0   1   1   1   0   0   0   0   0   0   0   0   0
1   1   1   1   1   1   1   1   0   0   0   0   0   0   1   1   1   1   1   1   1   0   0
1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
-------------------------------------------------------------------------------------------
1   1   1   1   1   1   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

           EPELZ                                  N

1   1   1   1   1   1   1   1   1   1   1   1   1   0   0   0   0   0   0   0   0   0   1
1   1   1   1   1   1   0   1   1   0   0   1   1   1   0   0   0   0   0   0   0   0   0
0   1   1   1   1   1   1   1   1   1   0   1   1   1   1   1   1   1   1   1   1   1   1
1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
-------------------------------------------------------------------------------------------
0   1   1   1   1   1   0   1   1   0   0   1   1   0   0   0   0   0   0   0   0   0   0
```

7

Sampl

```
LAZEWNIK PHASE 2 DOUBLES TREATED   AUG.29,1967

   ZEPELZN                                  Z             EPEL           ZN
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
Z           1  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  1
PREFIX 2
ZN          0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  0
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ------------------------------------------------------------------
            0  1  0  0  0  0  0  0  0  0  0  0  0  1  1  1  1  1  1  0  1  0

   ZEPELZN                                  Z             EPEL           Z
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
Z           1  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  0  1  1
PREFIX 2
Z           0  0  1  0  0  0  0  1  1  1  1  1  1  1  1  1  0  1  1  1  1  0
PREFIX 1
N           0  1  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ------------------------------------------------------------------
            0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  1  0  1  1  0  1  0

       IPA                                                IP
SUFFIX 3
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1
PREFIX 1
A           0  0  0  0  1  1  1  1  1  1  0  0  1  1  0  0  0  0  0  0  0  1
            ------------------------------------------------------------------
            0  0  0  0  1  1  1  0  1  1  0  0  1  0  0  0  0  0  0  0  0  1

       IPA    I                                           PA
SUFFIX 3
I           1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
SUFFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
PREFIX 2
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1
PREFIX 1
            1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
            ------------------------------------------------------------------
            1  1  1  1  1  1  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1
```

Sample Illustration of Grammatical Validation by Computer

```
     EPEL               ZN

1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  0  0  1

1  1  1  1  1  0  1  1  C  C  1  1  1  C  C  C  C  C  0  0  0  0

1  1  1  1  1  1  1  0  C  C  C  C  C  C  C  C  C  C  0  0  0  0

1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
------------------------------------------------------------------
1  1  1  1  1  0  1  0  C  C  0  C  C  C  C  C  C  C  0  0  0  0

     EPEL               Z                   N

1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  0  0  1

1  1  1  1  1  0  1  1  C  C  1  1  1  C  C  C  C  C  0  C  0  0

1  1  0  1  1  1  1  C  C  C  0  C  C  1  1  1  1  1  1  1  0  0

1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
------------------------------------------------------------------
1  1  0  1  1  0  1  C  C  C  C  C  C  C  C  C  C  C  0  0  0  0

     IP                                     A

1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  0  0  1

1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1

1  1  1  1  1  1  1  1  1  C  1  1  1  1  1  1  1  1  1  1  1  1

0  0  0  0  0  0  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
------------------------------------------------------------------
0  0  0  0  0  0  0  1  1  C  1  1  C  C  C  C  C  C  0  0  0  1

     PA

1  1  1  1  1  1  1  1  1  1  1  1  C  C  C  C  C  C  0  C  0  1

1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1

1  1  1  1  1  1  1  1  1  C  1  1  1  1  1  1  1  1  1  1  1  1

1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
------------------------------------------------------------------
1  1  1  1  1  1  1  1  1  C  1  1  C  C  C  C  C  C  0  0  0  1
```

CHAPTER IV

THE CONSTRUCTION OF A REFERENCE DICTIONARY

The introductory chapters dealt with the purposes and technique of the computer study. The final results of this study were embodied in combinations of fractionations of test words processed by the computer. Before determining the validity of the various combinations, their stems in turn must first be examined for valid status To do this, it is necessary to consult a specialized work, a specialized reference dictionary. This dictionary should contain systematized information touching upon all pertinent relationships of the given stem; grammatical, etymological and comparative philological aspects. That is, pertinent relationships apart from particular denotations. Therefore, it is to be expected that after the computer operations there may remain cases of semantic ambiguity.

Such a dictionary has been compiled. There are two main sections; verbs and nouns. The noun section is subdivided into nouns derived from verb roots and those not so.

Though present participles serve as nominals, they have not been listed with the nouns. Information regarding them was incorporated into the verb programming. The same is true for the infinitive construct. This was advisable in order to avoid duplication.

Organization of the Dictionary

In regard to each entry, the following features were noted:

1. Class index
2. Occurrence in idiomatic expression, or lack of occurrence
3. Part of speech
4. Declinability
5. Occurrence with prefixes B, K, L, M (מ,ל , כ,ב), or not
6. Occurrence with definite article Hé (ה) or not
7. Occurrence with conjunction Waw (ו) or not
8. Occurrence with conjunction Šin (ש) or not
9. Occurrence with Aramaic conjunction D (ד) or not
10. Literary or epochal source: Scripture (N); Talmud (Z); literature of the Middle Ages (A); literature of Modern Times (G)
11. Philological origin: Aramaic (⊕); Arabic (R): Greek (I); Latin (L)
12. Nouns of verbal origin (such nouns as PiQaDoN-- פקדון) were entered in a special section and their roots indicated at the same point. The unknown origin of such ele-

mentary nouns as *MaYiM* (מים), *LeḤeM* (לחם), *ŠuLḤaN* (שלחן), were not investigated.

13. In a separate column, a notation was made of the construction origin of the entry.
14. The *scriptio plena* was indicated at the corresponding point of a special column. The symbolization employed consisted of a plus (+), a number and the letter, usually E (*Waw*--ו) or I (*Yud*-י). The interpretation is as follows: Insert the required E or I in the position indicated by the number.

Each item listed above was indexed by an appropriate symbol indicated "yes" or "no" at the position of entry in the dictionary.

Comments

For the sake of clarification some further remarks have been thought to be of value. It is to be noted once more that the emphasis in this treatise has been almost completely on morphology. It should therefore not be a matter of surprise that entries in the dictionary have been ordered, often with striking disparity in semantic character, on the basis of form only.

Thus the three words *KFR* (כפר) denoting ransom, *KFR* (כפר) denoting pitch, *KFR* (כפר) denoting village, though so divergent in denotation, are equal morphologically with the exception that KFR (KéFaR) (כפר) meaning village, falls into a more distinguished morphologic class for the reason that it takes a plural form, a fact which is not true of the other two. Therefore, according to the rule that has been accepted for the organization of the dictionary, the first two belong to one class while the third belongs to a different class.

Item 2

The recording of idiomatics and compounds associated with a given entry will prove to be useful in enabling the computer to select such elements with preceding and/or following words from tested text material. A valuable tool will thus be furnished for characterizing literary features of the text.

Item 4

Though morphologically, every noun entry belongs to an appropriate declension, in practice, specific entries must obviously be excluded from these declension forms. For this reason, it was necessary to add a special column indicating declinability of the entry. In this regard it is impossible to apply a consistent rule. Even Šošan, in general, indicates declension forms for his entries. These were bodily included as declinable in our dictionary. In case of those nominals for which no declension forms are recorded in Even Šošan, the question became a matter of choice for the compiler. The judgement in this case depended upon the frequency of occurrence of the entry. A rare nominal the sense of which contrindicated declension, e.g. GYHNWM (GéHiNoM) (גיהנום) was listed as undeclinable. This was also done for abbreviations and acrostics.

Item 5

Although in general the various nominals may occur with the auxilaries B, K, L, M (ם, ל, כ, ב) D, H, W, S (ש, ה, ד, ו), nevertheless, it was necessary to specify the occurence in each case separately. Besides the obvious necessity in the case of abbreviations and acrostics, certain entries represent a new word unit resulting from fusion of auxilaries and original nominals. Illustration of the latter are B!RK (B!eReK) (בערך), LRGL (LéReGeL) (לרגל). These also exemplify certain traditional abbreviations employed in conjunction with auxilary elements which have become so naturalized into the language that Even Šošan in the 1967 edition of his dictionary, accepted them as fully matured terms. An extreme illustration of the conjuctive Waw (ו) is afforded by W'M T'MR (W'iM ToMaR) (ואם תאמר), abbreviated W'T, and by WYL (WyeŠ LoMaR) (ויש לומר). When Even Šošan employed two legends for the identical designation, as in the above examples, the reference dictionary made similar entries for the abbreviation.

Item 10

The literary period was judged by the morphology peculiar to the period rather than by the philologic origin of the entry. For example, *KBWD* (*KiBuD*) (כבוד), peculiar to the Mišna period though the radical *KBD* (כבד) is frequent in scripture; *'DYŠ* (*ADiŠ*) (אדיש) was marked as a modern term even though the radical *'DŠ* (ADŠ) (אדש) is Aramaic.

Item 12

The original intention in reference toitem 12 was to assemble a sufficiently large collection of detail which could lead to the formulation of principles for the formation of nominals of verbal origin. However, this was found to constitute a study not as yet undertaken, and too overambitious a study from the point of view of the present purpose.

Item 13

This feature, since its importance for the study of stem recognition was not high, was excluded at first when planning the construction of the dictionary. However, for the sake of completeness, it was finally decided to include this additional feature on the possibility that appertaining considerations would prove of measurable importance in the further study of the subject. The column indicating the construction from which the entry is derived is therefore lacking in some of the alphabetical listings.

CHAPTER V

CLASSIFICATION OF NOUNS

The dictionary *Milon Haḥadaš*[1] was thoroughly scrutinized for the purpose of drawing up the listing of the noun section of our reference dictionary. Those nouns which are the more specialized technical terms, or international terms of foreign origin, or generic nouns which occur very infrequently, were not included in the compilation, according to the discretion of the compiler. A record was kept, however, of those words which were omitted.

Forty-three[2] noun models were prepared indicating the basic noun, feminized form if existent, plural masculine or feminine if relevant. Each model is based on a special characteristic which represents regularities governed by rules which determine the formation of the feminine, when existent, the construct state, and the plural with its special morphology.

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[1] Even Šošan, *Milon Hahadaš*, Jerusalem, 1967. (The first three volumes only, the rest of the dictionary was based on the 1962 edition.)

[2] The preparation of these models was influenced by the set of twenty-two models contained in *Lĕšonénu*, *op. cit.*, appendix 3. I thank Mr. Cheuoka for sending me a corrected and revised list of twenty-eight models. This study, however, has established a higher number (43) of distinct classes.

Certain anamalous noun specimens, singular and plural, were entered individually in the dictionary. The entire list of noun classes with explanation follows.

Table of Noun Classes

In.	G.	Model Form Abs.	Fem. Sing. Abs.	Fem. Sing. Con.	Masc. Pl. Abs	Masc. Pl. Con.	Fem. Pl. Abs.	Fem. Pl. Con.
1	M	YLD - ילד	YLDH ילדה	YLD(H)T ילדת	YLDYM ילדים	YLDY(M) ילדי	YLD(H)WT ילדות	---
2	M	GBR - גבר	GBRT גברת	---	GBRYM גברים	GBRY(M) גברי	GBR(T)WT גברות	---
3	M	QN'Y - קנאי	QN'YT קנאית	---	QN'YM קנאים	QN'Y(M) קנאי	QN'Y(T)WT קנאיות	---
4	M	!Z̲LN - עצלן	!Z̲LNYT עצלנית	---	!Z̲LNYM עצלנים	!Z̲LNY(M) עצלני	!Z̲LNY(T)WT עצלניות	---
5	M	MWRH - מורה	MWRH מורה	MWR(H)T מורת	MWR(H)YM מורים	MWR(H)Y(M) מורי	MWR(H)WT מורות	---
6	M	DGL - דגל	---	---	DGLYM דגלים	DGLY(M) דגלי	---	---
7	M	ḤLWN - חלון	---	---	ḤLWNWT חלונות	---	---	---
8	M	MQRH - מקרה	---	---	MQR(H)YM מקרים	---	---	---
9	M	MKRH - מכרה	---	---	MKR(H)WT מכרות	---	---	---
10	F	ŠMLH - שמלה	---	ŠML(H)T שמלת	---	---	ŠML(H)WT שמלות	---
11	F	ḤṬH - חטה	---	ḤṬ(H)T חטת	---	---	ḤṬ(H)YM חטים	ḤṬ(H)Y(M) חטי

Table of Noun Classes

In.	G.	Model Form Abs.	Fem. Sing. Abs.	Fem. Sing. Con.	Masc. Pl. Abs.	Masc. Pl. Con.	Fem. Pl. Abs.	Fem. Pl. Con.
12	F	TNWQT - תנוקת	---	---	---	---	TNWQ(T)WT תנוק ות	---
13	F	MLK̲WT - מלכות	---	---	---	---	MLK̲(WT)YWT מלכיות	---
14	F	MṬLYT - מטלית	---	---	---	---	MṬLY(T)WT מטליות	---
15	F	RGL - רגל	---	---	---	---	RGLYM רגלים	RGLY(M) רגלי
16	F	'Z̲B! - אצבע	---	---	---	---	'Z̲B!WT אצבעות	---
17	M	NḤM - נחם	---	---	---	---	---	---
18	F	TBL - תבל	---	---	---	---	---	---
19	F	'ḤWH -אחוה	---	'ḤW(H)T אחות	---	---	---	---
20	M	ŠMYM -שמים	---	---	---	ŠMY(M) שמי	---	---
21	M	QWŠṬ -קושט	QWŠṬH or QWŠṬT קושטת or קושטה	---	QWŠṬYM קושטים	QWŠṬY(M) קושטי	QWŠṬ(H or T)WT קושטות	
22	M	'YŠ - איש	---	---	'NŠYM אנשים	'NŠY אנשי	---	---

Table of Noun Classes

In.	G.	Model Form Abs.	Fem. Sing. Abs.	Fem. Sing. Con.	Masc. Pl. Abs.	Masc. Pl. Con.	Fem. Pl. Abs.	Fem. Pl. Con.
23	F	'M - אם	---	---	---	---	'MHWT אמהות	---
24	F	'ŠH - אשה	---	---	---	---	NŠYM נשים	---
25	-	'B- אב(the month) and LK' - לכא	---	---	---	---	---	---
26	-	'BL - אבל	---	---	---	---	---	---
27	M	RḤMN - רחמן	RḤMNYH or RḤMNYT רחמניה or רחמנית	---	RḤMNYM רחמנים	---	RḤMNY(H or T)WT רחמניות	---
28	M	RŠ! - רשע	RŠ!H or RŠ!YT רשעה or רשעית	---	RŠ!YM רשעים	---	RŠ!(H or YT)WT רשעות	---
29	M	QŠṬ - קשט	---	---	---	---	---	---
30	M	HB'Y - הבאי	HB'YT הבאית	---	HB'YYM הבאיים	---	HB'Y(T)WT הבאיות	---
31	M	HGH - הגה	---	---	HG(H)YM and HG(H)'YM הגים and הגאים	---	---	---
32	M	MŠTH - משתה	---	---	MŠT(H)'WT משתאות	---	---	---
33	M	HWMH - הומה	HWMYH הומיה	---	HWM(H)YM הומים	---	HWMY(H)WT הומיות	---

Table of Noun Classes

In.	G.	Model Form Abs.	Fem. Sing. Abs.	Fem. Sing. Con.	Masc. Pl. Abs.	Masc. Pl. Con.	Fem. Pl. Abs.	Fem. Pl. Con.
34	M	HWRMN' - הורמנא	---	---	HWRMN(')WT הורמנות	---	---	---
35	M	'YQWNYN- איקונין	---	---	'YQWNY(N)YWT איקונייות	---	---	---
36	F	'YŠYWT- אישיות	---	---	---	---	'YŠYWT אישיות	---
38	F	'YMH - אימה	---	'YM(H)T אימת	---	---	'YM(H)YM or 'YM(H)WT אימים or אימות	'YMY(M) אימי
39	F	'K̲SDRH - אכסדרה	---	'K̲SDR(H)T אכסדרת	---	---	'K̲SDR(H)'WT אכסדראות	---
40	F	'MRH - אמרה	---	'MR(H)T אמרת	---	---	'MR(H)WT or 'MR(H)YWT אמריות or אמרות	---
41	F or M	ŠH - שה	---	---	Š(H)YYM שיים	---	Š(H)YWT שיות	---
42	F	Š!W!YT- שעועית	---	---	---	---	Š!W!Y(T)M שעועים	---
43	M	NK̲PH - נכפה	NK̲P(H)YT נכפית	---	NK̲P(H)YM נכפים	---	NK̲P(H)WT נכפות	---
44	M	ZWGDWS- זוגדוס	ZWGDWSYT זוגדוסית	---	ZWGDWSYM זוגדוסים	---	ZWGDWSWT זוגדוסות	---

Description of Classes in Table of Nouns

In.	Model Form	
1.	YLD - ילד	Feminine form characterized by addition of a final Hé (ה) to masculine form.
2.	GBR - גבר	Feminine form characterized by addition of a final Taw (ת) to masculine form.
3.	QN'Y קנאי	Masculine plural characterized by addition of a final Mem (ם).
4.	!ZLN - עצלן	Feminine form characterized by addition to masculine form of Yud Taw (ית) for singular and Yud Waw Taw (יות) for plural.
5.	MWRH - מורה	Masculine form, singular, characterized by final (segol) Hé (ה); plural forms, masculine and feminine, characterized by dropping of final Hé (ה).
6.	DGL - דגל	Masculine form only; plural formed by addition of Yud Mem (ים).

In.	Model Form	
7.	ḤLWN - חלון	Masculine form only; plural formed by addition of Waw Taw (ות).
8.	MQRH - מקרה	Same as number 5, but masculine form only; plural formed by final Yud Mem (ים).
9.	MKRH - מכרה	Same as number 8, but plural formed by final Waw Taw (ות).
10.	ŠMLH - שמלה	Regular feminine form characterized by final (Kometz) Hé (ה); plural formed by dropping final Hé (ה) and adding Waw Taw (ות).
11.	ḤṬH - חטה	Regular feminine form characterized by final Hé (ה); plural formed by dropping final Hé (ה) and adding Yud Mem (ים).
12.	TNWQT - תנוקת	Feminine form characterized by final Taw (ת); plural formed by dropping final Taw (ת) and substituting Waw Taw (ות).

In.	Model Form	
13.	MLK̲WT - מלכות	Feminine form characterized by final Waw Taw (ות); plural formed by dropping final Waw Taw and substituting Yud Waw Taw (יות).
14.	MṬLYT - מטלית	Feminine form characterized by final Yud Taw (ית); plural formed by dropping final Taw (ת) and substituting Waw Taw (ות).
15.	RGL - רגל	Feminine without special characteristics; plural formed by final Yud Mem (ים).
16.	'Z̲B! - אצבע	Same as number 15; plural formed by final Waw Taw (ות).
17.	NḤM - נחם	Masculine, singular form only.
18.	TBL - תבל	Feminine, singular form only.
19.	'ḤWH - אחוה	Feminine with final Hé (ה), singular form only.
20.	ŠMYM - שמים	Masculine, plural form only.

In.	Model Form	
21.	QWŠṬ - קושט	Regular present participles serving as nominals.
22.	'YŠ - איש	Masculine with special plural form.
23.	'M - אם	Feminine with special plural form.
24.	'ŠH - אשה	Feminine characterized by final Hé (ה), with special plural form.
25.	'B (the month)- אב and LḴ' - לכא	Unique forms and "loan-words" of foreign origin which have no plural.
26.	'BL - אבל	Parts of speech exclusive of nouns and verbs
27.	RḤMN - רחמן	Feminine form characterized by final Yud Hé (יה) or Yud Taw (ית); plural formed by final Yud Waw Taw (יות).
28.	RŠ! - רשע	Feminine form characterized by either final Hé (ה) or Yud Taw (ית).

In.	Model Form	
29.	QŠṬ - קשט	Infinitive construct serving as a noun (verbal noun).
30.	HB'Y - הבאי	Same as number 3, but masculine plural formed by final Yud Mem (ים).
31.	HGH - הגה	Same as number 5, but plural forms either drop the final Hé (ה) and Substitute Alef Yud Mem (אים) or Yud Mem (ים).
32.	MŠTH - משתה	Same as number 9, but plural formed by dropping final Hé (ה) and substituting Alef Waw Taw (אות).
33.	HWMH - הומה	Same as number 5, but feminine occurs also in final Yud Hé (יה), plural formed ALSO with Yud Waw Taw (יות).
34.	HWRMN' - הורמנא	Noun ending in Alef (א), plural formed by dropping the final Alef (א) and substituting Waw Taw (ות).

In.	Model Form	
35.	'YQWNYN - איקונין	Noun ending in Nun (ן), plural formed by dropping final Nun (ן) and substituting Yud Waw Taw (יות).
36.	'YŠYWT - אישיות	Noun ending in Yud Waw Taw (יות), plural formed by substituting Yud Waw Taw (YoT) for Yud Waw Taw (YuT) (יות); i.e. singular and plural consonantal form invariant.
38.[3]	'YMH - אימה	Feminine with final Hé (ה); plural either formed by dropping final Hé (ה) and substituting Yud Mem (ים) or Waw Taw (ות).
39.	'KSDRH - אכסדרה	Feminine with final Hé (ה); plural formed by dropping final Hé and substituting Alef Waw Taw (אות).

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[3] Number 37 is missing. The order of listing was determined by the development of the process of study rather than in accordance with strict logic.

In.	Model Form	
40.	'MRH - אמרה	Same as number 39; plural formed by dropping final *Hé* (ה) and substituting either *Waw* *Taw* (ות) or *Yud* *Waw* *Taw* (יות).
41.	ŠH - שה	Noun with final (segol) *Hé* (ה); either masculine or feminine; plural formed by dropping final *Hé* (ה) and substituting *Yud* *Yud* *Mem* (יים) (masculine) or *Yud* *Waw* *Taw* (יות) (feminine).
42.	Š!W!YT - שערעית	Feminine noun ending in *Yud* *Taw* (ית); plural formed by dropping the final *Taw* (ת) and substituting *Mem* (ם).
43.	NKPH - נכפה	Feminine form characterized by dropping final (segol) *Hé* (ה) and substituting *Yud* *Taw* (ית), plural regular.
44.	ZWGDWS - זוגדוס	Same as number 43, but masculine form is not final (segol) *Hé* (ה).

CHAPTER VI

CLASSIFICATION OF VERBS

The list of verbs was selected from the verb tables of Dr. S. Barkoli.[1] It was notable to what extent the respective verb collection of Dr. Barkoli and Even Šošan did not coincide.[2] Though I followed Barkoli's list, I nevertheless found it necessary to add some very common verbs that apparently had been omitted through oversight: QNH (קנה),[3] RḤQ (רחק).

In general I was able to set up an indexical correspondence between my listing and that of Dr. Barkoli. Much condensing of Dr. Barkoli's list was involved in the process since necessarily Dr. Barkoli's preoccupation with such elements as vocals and semivocals was extraneous to this research which is based on consonants. In certain cases it was necessary to depart radically from Dr. Barkoli's premises for the sake of systematization. To illustrate, Dr. Barkoli treats the radicals ZWG, KWN (זוג, כון) in the conventional manner applicable to Ayin-Waw (ע"ו) verbs. However, in the Pi!el (פיעל) construction, for example, while the Nun (ן) of KWN may coalesce with an appropriate suffix, the Gimel (ג) of ZWG (זוג) will not be so affected. This disappearance of a radical in one case and its retention in the other will pose a problem for the computer. I therefore considered ZWG (זוג) in the Pi!el construction as an instance of the Šlémim (שלמים), disregarding the standard Ayin-Waw (ע"ו) form.

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[1] Dr. S. Barkoli, Luaḥ Happ'əlim HaŠalém (Complete Verb Tables), Jerusalem, fourteenth edition 1966.

[2] We have recorded separately the distinctive verbs from Lamed (ל) to Taw (ת) of each collection.

[3] Although QNH (קנה) is omitted from Barkoli's listing, it is employed by him as a model in the Pa!al construction (#31).

A further illustration: Barkoli considers the radicals YZ' (יצא) and QR' (קרא) identical in kind.[4] The complication introduced by the Yud (י) in YZ' (יצא) is discussed in a seperate footnote. However, for the purpose and method of our study the presence of an initial Yud (י) in the radical emphasizes an important distinction between both classes of radicals which we cannot afford to overlook. In contrast, because of the consonantal emphasis given to our method of operation, the radical distinction in vocalization in such forms as the infinitive, e.g. *LaZéT* (לצאת), *LaŠeVeT* (לשבת) is of no concern.

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[4] Barkoli, op. cit. p. 72.

Similarly, Dr. Barkoli does not differentiate between such radicals as *NŠ'* (נשא) and *SM'* (סמא). These are placed into an identical class despite the regular *Hitpa!el* (התפעל) conjugation of *NŠ'* (נשא) on one hand, and the transposition of the *Taw* (ת) in the *Hitpa!el* of *SM'* (סמא) on the other. The same is strikingly illustrated in the case of Barkoli's classification of *SLḤ* (סלח). Although it is correct to assign this radical equally to the *Lamed Ḥet* (ל"ח) class of *YKḤ* (יכח), the marked morphological change (the change of the *Yud-* י to *Waw-* ו) in the *Hitpa!el* of the latter is, nevertheless, thereby entirely obscured.

Thus while on the one hand, it was possible in general to condense much of Dr. Barkoli's listing, on the other hand, there also had to be considerable amplification of his list, since many of the aspects of Dr. Barkoli's systematization brought about the disappearance of relevant consonantal structure, as herein shown.

In brief, while basing the study solidly on Barkoli's system, the special circumstances of the problem necessitated a departure in three ways generally: the equating of different, distinct classes defined by Barkoli; reclassification based on Barkoli's footnotes; analysis of individual classes defined by Barkoli into multiple classes and into the unclassified.

This threefold procedure induced the organization of the verb lists:

L 1. Indexical correspondence of Source (Barkoli) and Project

L 2. Reclassifications

L 3. Special classes and unclassified

The Present Participle

In case of present participles which are traditionally written plena, I have considered as legitimate the defective spelling as well, since this would embrace the characteristics of certain types of literature. This type of present participle, therefore, has been placed into one class, while those so vocalized as not to permit a Waw are placed into another. This too, is a departure from Barkoli's system.

Orthography of Verbs

In the matter of orthography of verbs, the scriptia plena and defectiva were given equal consideration in planning the programming, e.g. the imperfect of Pa!al (פעל); YQŠṬ (YIQŠoṬ) (יקשט) and YQŠWṬ (YiQŠoṬ) (יקשוט); in Pi!el (פיעל), QŠṬ (QiŠeṬ) (קשט) and QYŠṬ (QiŠeṬ) (קישט); and in Pu!al (פועל), QŠṬ (QuŠaṬ) (קשט) and QWŠṬ (QuŠaṬ) (קושט).

The Passive Participle

With reference to the mechanics of the computer, consideration of the distinction between transitive and intransitive verbs was a factor of great importance. The passive participle form was functionally automatically included with each transitive verb. This is justified by the grammatical significance of the transitive, namely, that the recipient of an action is the potential subject of the intransitive form of the verb designating the action. The same could not be said for intransitive verbs, in which case, special adjustments were required.

The above considerations permitted considerable economy in the matter of devising of necessary listings touching upon the passive participles. The mere indication of the transitive, suffices, as respects the computer, for enjoining computations relevant to inclusion of the passive participle form.

Intransitives that Govern an Accusative[5]

1. 'DM - אדם
2. 'RK̲ - ארך
3. HGN - הגן
4. ḤLŠ - חלש
5. ḤMR - חמר
6. ḤŠK̲ - חשך
7. KBH - כבה
8. MTN - מתן
9. MTQ - מתק
10. !GM - עגם
11. !DŠ - ערש
12. !Z̲M - עצם
13. Z̲FF - צפף
14. Z̲RD - צרד
15. RDM - רדם
16. RHN - רהן
17. RQB - רקב
18. TŠŠ - תשש

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[5] This list is based exclusively on Barkoli's *Luaḥ Happe!olim*.

(L1) Indexical Correspondence of Source and Project

Construction Alef--Pa!al --- פעל (א)

Source	Project	Source	Project
1	1	22	7
2	1	23	8
3	1	24	8
4	1	25	9
5	2	26	1
6	1	27	1
7	1	28	2
8	1	29	1
9	3	30	9
10	2	31	10
11	2	32	10
12	4	33	10
13	1	34	10
14	2	35	10
15	1	36	10
16	1	37	11
17	1	38	12
18	2	39	13
19	5	40	12
20	5	41	12
21	6	42	12

(L1) Indexical Correspondence of Source and Project

Construction Alef (continued)--Pa!al-- פעל (א)

Source	Project	Source	Project
43	14	55	20
44	14	56	20
45	14	57	13
46	15	58	23
47	15	59	24
48	16	60	9
49	17	61	21
50	17	62	10
51	18	63	10
52	19	64	15
53	19	65	15
54	20	66	22

(L1) Indexical Correspondence of Source and Project

Construction Bet -- Nif!al-- נפעל -- (ב)

Source	Project	Source	Project
1	1	20	4
2	1	21	4
3	1	22	4
4	1	23	4
5	1	24	4
6	1	25	5
7	1	26	6
8	1	27	6
9	1	28	7
10	1	29	7
11	1	30	8
12	2	31	9
13	2	32	10
14	2	33	10
15	3	34	11
16	3	35	11
17	1	36	12
18	1	37	13
19	3		

(L1) Indexical Correspondence of Source and Project

Construction Gimel -- Pi!el-- פיעל --(ג)

Source	Project	Source	Project
1	1	15	3
2	1	16	3
3	1	17	4
4	1	18	4
5	1	19	5
6	1	20	5
7	1	21	6
8	1	22	3
9	1	23	7
10	1	24	1
11	1	25	8
12	1	26	8
13	2	27	8
14	2	28	9

(L1) Indexical Correspondence of Source and Project

Construction Dalet -- Pu'al-- פועל -- (ד)

Source	Project	Source	Project
1	1	16	2
2	1	17	2
3	1	18	3
4	1	19	3
5	1	20	4
6	1	21	4
7	1	22	5
8	1	23	3
9	1	24	6
10	1	25	7
11	1	26	1
12	1	27	8
13	1	28	8
14	1	29	8
15	1	30	9

(L1) Indexical Correspondence of Source and Project

Construction He--Hitpa!el-- (ה)-- התפעל

Source Project

1---------------1

2---------------1

3---------------1

4---------------1

5---------------1

6---------------1

7---------------1

8---------------1

9---------------2

10--------------1

11--------------3

12--------------3

13--------------4

14--------------4

15--------------5

16--------------5

17--------------5

18--------------5

19--------------5

20--------------6

21--------------6

22--------------1

Source Project

23--------------1

24--------------7

25--------------7

26--------------8

27--------------9

28-------------10

29-------------11

30-------------12

31------------8

32-------------13

33--------------1

34-------------14

35-------------14

36-------------15

37-------------16

38-------------17

39-------------17

40-------------18

41-------------14

42-------------14

43-------------19

(L1) Indexical Correspondence of Source and Project

Construction Waw--Hif!il-- הפעל --(ו)

Source	Project	Source	Project
1	1	21	6
2	1	22	7
3	1	23	8
4	1	24	8
5	1	25	9
6	1	26	9
7	1	27	10
8	1	28	11
9	2	29	10
10	2	30	11
11	1	31	11
12	3	32	12
13	4	33	13
14	4	34	11
15	1	35	14
16	1	36	14
17	1	37	15
18	5	38	14
19	5	39	14
20	5	40	1

(L1) Indexical Correspondence of Source and Project

Construction Zayin--Hof!al-- הופעל --(ז)

Source	Project	Source	Project
1	1	15	1
2	1	16	5
3	1	17	5
4	1	18	6
5	1	19	7
6	1	20	8
7	1	21	9
8	2	22	10
9	2	23	9
10	3	24	10
11	4	25	11
12	4	26	12
13	1	27	12
14	1	28	1

Description of Classes (L1)--Project Classification

Construction Alef -- Pa!al-- פעל --(א)

In.	Conj. Model	
1.	ŠMR - שמר	(Regular) Šlémim (שלמים)
2.	DBK - דבק	(Regular) Šlémim (שלמים) but participle has no Waw (ו).
3.	'MZ - אמץ	(Regular) Šlémim (שלמים) but participle has no Yud (י).
4.	'KL - אכל	Pé Alef (פ"א)
5.	YŠB - ישב	Pé Yud (פ"י) The Yud (י) is dropped in the perfect and imperative; infinitive may retain Yud (לישב) or occur in the !LeT form (SBT-- שבת).
6.	YZQ - יצק	Same as number 5 but the imperative may drop or retain the Yud (י).
7.	NPL - נפל	Pé Nun (פ"נ) Nun (נ) is dropped only in the imperfect.

Description of Classes (L1)--Project Classification

Construction Alef --Pa!al-- פעל --(א) continued

In.	Conj. Model	
8.	NŠQ - נשק	Same as number 7, but the Nun (נ) is also dropped in the imperative.
9.	NPḤ - נפח	Same as number 8, but the infinitive is in the !LT and !L forms; Paḥat (פחת) and Paḥ (ליפח).
10.	QNH - קנה	Lamed Hé (ל"ה)
11.	NṬH - נטה	Pé Nun-Lamed Hé (פ"נ--ל"ה)
12.	ṬMN - טמן	Lamed-Nun (ל"ן)
13.	ZQN - זקן	Lamed-Nun (ל"ן), The participle has no Waw (ו).
14.	KRT - כרת	Lamed-Taw (ל"ת)
15.	QWM - קום	!Ayin-Waw (ע"ו)
16.	LWN - לון	!Ayin-Waw Lamed-Nun (ע"ו--ל"ן)
17.	SYM - שים	!Ayin-Yud (ע"י)
18.	DYN - דין	!Ayin-Yud Lamed-Nun (ע"י--ל"ן)
19.	ḤGG - חגג	!Ayin-!Ayin (ע"ע)

Description of Classes (L1)--Project Classification

Construction Alef--Pa!al-- פעל --(א)continued

In.	Conj. Model	
20.	QBB - קבב	!Ayin-!Ayin (ע"ע) But the participle assumes the !Ayin-Waw (ע"ו) form.
21.	NTN - נתן	Pé-Nun Lamed-Nun (פ"נ -- ל"ן)
22.	MWT - מות	!Ayin-Waw Lamed Taw (ע"ו -- ל"ת)
23.	YGR - יגר	Pé-Yud (פ"י) Has !Ayin-Yud (ע"י) characteristics.
24.	YKL - יכל	Anomalous Pé-Yud (פ"י)

Description of Classes (L1)--Project Classification

Construction Bet--Nif!al-- נפעל --(ב)

In.	Conj. Model	
1.	ŠMR - שמר	(Regular) Šlémim (שלמים)
2.	YSD - יסד	Pé-Yud (פ"י)
3.	NGF - נגף	Pé-Nun (פ"נ)
4.	GLH - גלה	Lamed-Hé (ל"ה)
5.	NṬH - נטה	Pé-Nun Lamed-Hé (פ"נ -- ל"ה)
6.	ṬMN - טמן	Lamed-Nun (ל"ן)
7.	KRT - כרת	Lamed-Taw (ל"ת)
8.	SWG - סוג	!Ayin-Waw (ע"ו)
9.	BYN - בין	!Ayin-Yud (ע"י)
10.	ẔWD - צוד	!Ayin-Waw (ע"ו) But perfect assumes Šlémim form.
11.	SBB - סבב	!Ayin-!Ayin (ע"ע)
12.	BZZ - בזז	!Ayin-!Ayin (ע"ע) With Waw (ו) in the imperfect.
13.	ḤLL - חלל	!Ayin-!Ayin (ע"ע) Without Waw in perfect.

Description of Classes (L1)--Project Classification

Construction Gimel--Pi!el-- פיעל --(ג)

In.	Conj. Model	
1.	DBR - דבר	(Regular) Šlémim (שלמים)
2.	ZWH - צוה	Lamed-Hé (ל"ה)
3.	SKN - סכן	Lamed-Nun (ל"ן)
4.	'MT - אמת	Lamed-Taw (ל"ת)
5.	QWM - קום (QWMM)-קומם	!Ayin-Waw (ע"ו) Po!alti form.
6.	QWM - קום (QYM)- קים	!Ayin-Waw (ע"ו) Pi!alti form.
7.	SBB - סבב	!Ayin-!Ayin (ע " ע)
8.	PRNS - פרנס	(Regular) Šlémim (שלמים) Quadriliteral. (מרובעים)
9.	!NYN - עניין	Quadriliteral final radical Nun (מרובעים ל" ן).

Description of Classes (L1)--Project Classification

Construction Dalet--Pu!al-- פעל --(ד)

In.	Conj. Model	
1.	KBD - כבד	(Regular) Šlémim (שלמים)
2.	ZWH - צוה	Lamed-Hé (ל"ה)
3.	SKN - סכן	Lamed-Nun (ל"ן)
4.	ZMT- צמת	Lamed-Taw (ל"ת)
5.	QWM - קום (QWMM)- קומם	!Ayin-Waw (ע"ו) P olal form.
6.	QWM - קום (QYM)- קים	!Ayin-Waw (ע"ו) Pu!al form, the Waw (ו) changes to Yud (י).
7.	!L!L - עלעל	Quadriliteral of the P o!aL form.
8.	GLGL - גלגל	Quadriliteral of the Pu!aL form.
9.	!NYN - עניין	Quadriliteral of Lamed-Nun (מרובעים ל"ן)

Description of Classes (L1)--Project Classification

Construction Hé--Hitpa!el-- התפעל --(ה_)

In.	Conj. Model	
1.	KŠR - קשר	(Regular) Šlémim (שלמים)
2.	YKḤ - יכח	Pé-Yud (פ"י)
3.	ZQF - זקף	Pé-Zayin (פ"ז)
4.	ZDQ - צדק	Pé-Zadi (פ"צ)
5.	SDR - סדר	Pé-Samaḥ or Šin (פ"ס or ש)
6.	DBQ - דבק	Pé-Dalet (פ"ד)
7.	GLH - גלה	Lamed-Hé (ל"ה)
8.	'MN - אמן	Lamed-Nun (ל"ן)
9.	'MT - אמת	Lamed-Taw (ל"ת)
10.	QWM - קום (QWMM)-קוממ	!Ayin-Waw (ע"ו)
11.	BYN - בין	!Ayin-Yud (ע"י)
12.	QWM - קום (QYM)- קים	!Ayin-Waw (ע"ו)
13.	GLL - גלל	!Ayin-!Ayin (ע"ע)
14.	PRNS - פרנס	Regular Quadriliteral (שלמים מרובעים)
15.	GLGL - גלגל	Quadriliteral of Pé-Zayin (מרובעים פ"ז)
16.	ZMZM - צמצם	Quadriliteral of Pé-Zadi (מרובעים פ"צ)
17.	SLSL - סלסל	Quadriliteral of Pé-Samah or Sin (מרובעים פ"ס or ש)
18.	DLDL - דלדל	Quadriliteral of Pé-Dalet (מרובעים פ"ד)
19.	!NYN - עניין	Quadriliteral of Lamed-Nun (מרובעים ל"ן)

Description of Classes (L1)--Project Classification

Construction Waw--Hif!il-- הפעיל --(ו)

In.	Conj. Model	
1.	QẔR - קצר	(Regular) Šlémim (שלמים)
2.	YRD - ירד	Pé-Yud (פ " י)
3.	YẔB - יצב	Pé-Yud (פ " י) No transmutation of Waw (ו); Yud (י) dropped.
4.	NPL - נפל	Pé-Nun (פ"נ)
5.	QNH - קנה	Lamed-Hé (ל "ה)
6.	YRH - ירה	Pé-Yud Lamed-Hé (פ " י -- ל"ה)
7.	NKH - נכה	Pé-Nun Lamed-Hé (פ " נ -- ל"ה)
8.	ZQN - זקן	Lamed-Nun (ל"ן)
9.	ŠḤT - שחת	Lamed-Taw (ל"ת)
10.	QWM - קום	!Ayin-Waw (ע"ו) But perfect may also assume Hap'iloti form (הפעילותי)
11.	PWR - פור	!Ayin-Waw (ע"ו) Héf!alti form (הפעלתי).
12.	BYN - בין	!Ayin-Yud Lamed-Nun (ע " י -- ל " ן)
13.	MWT - מות	!Ayin-Waw Lamed-Taw (ע "ו -- ל"ת)
14.	SBB - סבב	!Ayin-!Ayin (ע " ע) May also assume the Haf!iloti (הפעילותי) form.
15.	TLL - תלל	!Ayin-!Ayin of Héf!alti (הפעלתי) form.

Description of Classes (L1)--Project Classification

Construction Zayin--Hof!al--הפעל--(ז)

In.	Conj. Model	
1.	QZ̲R - קצר	(Regular) Šlémim (שלמים)
2.	YRD - ירד	Pé-Yud (פ " י)
3.	YZ̲B - יצב	Pé-Yud (פ " י)
4.	NGŠ - נגש	Pé-Nun (פ " נ)
5.	GLH - גלה	Lamed-Hé (ל "ה)
6.	NKH - נכה	Pé-Nun Lamed-Hé (פ " נ-- ל"ה)
7.	ZMN - זמן	Lamed-Nun (ל"ן)
8.	ŠḤT - שחת	Lamed-Taw (ל"ת)
9.	QWM - קום	!Ayin-Waw (ע"ו)
10.	BYN - בין	!Ayin-Yud (ע"י)
11.	MWT - מות	!Ayin-Waw Lamed-Taw (ע "ו --ל "ת)
12.	ḤLL - חלל	!Ayin-!Ayin (ע"ע)

(L2) Reclassification

Construction Alef--Pa!al-- פעל --(א)

1.	DBQ -	דבק	Also conjugation number 1.
2.	ḤBR -	חבר	Withdrawn from conj. number 2.
3.	ḤNB -	חנב	Withdrawn from conj. number 2.
4.	ḤNF -	חנף	Withdrawn from conj. number 2.
5.	ḤRZ̲ -	חרץ	Withdrawn from conj. number 2.
6.	ḤŠK -	חשך	Also conjugation number 1.
7.	Y'B -	יאב	Reclassified to conj. number 1.
8.	YHR -	יהר	Also conjugation number 3.
9.	YZ̲' -	יצא	Reclassified to conj. number 5.
10.	YZ̲Q -	יצק	Also conjugation number 5.
11.	YZ̲R -	יצר	Also conj. number 1
12.	YQD -	יקד	Also conjugation number 1.
13.	YQR-	יקר	Also conjugation number 2.
14.	YSM -	ישם	Also conjugation number 1.
15.	YŠN -	ישן	Reclassified to conj. number 13.
16.	NDḤ -	נדח	Reclassified to conj. number 7.
17.	NṬ! -	נטע	Reclassified to conj. number 7 and 9.
18.	!LZ -	עלז	Reclassified to conj. number 2 and 3.
19.	!RB -	ערב	Reclassified to conj. number 1 and 2.
20.	ŠDD -	שדד	Reclassified to conj. number 1 and 19.
21.	ŠMḤ -	שמח	Reclassified to conj. number 1.

(L2) Reclassification

Construction Gimel--Pi!el-- פיעל --(ג)

1. ZWG - זוג Reclassified to conj. number 1.

2. GNN - גנן Reclassified to conj. number 3.

(L2) Reclassification

Construction He--Hitpa!el--התפעל--(ה)

(Reclassification based on changes governed by the first radicals T, T, Z̲, Z, S, S: ש, ס, ז , צ, ט , ת)

1.	DBQ*-	דבק	Reclassified to conj. number 1.
2.	LQḤ*-	לקח	Reclassified to conj. number 1.
3.	ZRḤ -	זרח	Reclassified to conj. number 3.
4.	ZQQ -	זקק	Reclassified to conj. number 3.
5.	Z̲B! -	צבע	Reclassified to conj. number 4.
6.	Z̲WḤ -	צוח	Reclassified to conj. number 4.
7.	Z̲ḤQ -	צחק	Reclassified to conj. number 4.
8.	Z̲L! -	צלע	Reclassified to conj. number 4.
9.	Z̲MḤ -	צמח	Reclassified to conj. number 4.
10.	Z̲NḤ -	צנח	Reclassified to conj. number 4.
11.	Z̲N! -	צנע	Reclassified to conj. number 4.
12.	Z̲!F -	צעף	Reclassified to conj. number 4.
13.	Z̲!R -	צער	Reclassified to conj. number 4.
14.	Z̲RB -	צרב	Reclassified to conj. number 4.
15.	Z̲R! -	צרע	Reclassified to conj. number 4.
16.	Z̲RḤ -	צרח	Reclassified to conj. number 4.
17.	S'B -	סאב	Reclassified to conj. number 5.
18.	SBB -	סבב	Reclassified to conj. number 5.
19.	SḤB -	סחב	Reclassified to conj. number 5.
20.	SḤF -	סחף	Reclassified to conj. number 5.

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* Asterisk indicates that the given class is an addition to the corresponding regular conjugation noted in List 1 (L1).

(L2) Reclassification

Construction He--Hitpa!el--התפעל--(ה) continued

21.	SY!-	סיע	Reclassified to conj. number 5.
22.	SLH -	סלח	Reclassified to conj. number 5.
23.	SM' -	סמא	Reclassified to conj. number 5.
24.	S!D -	סעד	Reclassified to conj. number 5.
25.	S!F -	סעף	Reclassified to conj. number 5.
26.	S!R -	סער	Reclassified to conj. number 5.
27.	SPH -	ספח	Reclassified to conj. number 5.
28.	SRH -	סרח	Reclassified to conj. number 5.
29.	S'B -	שאב	Reclassified to conj. number 5.
30.	S'G -	שאג	Reclassified to conj. number 5.
31.	S'F -	שאף	Reclassified to conj. number 5.
32.	S'R -	שאר	Reclassified to conj. number 5.
33.	SBH -	שבח	Reclassified to conj. number 5.
34.	(1) SB! -	שבע	Reclassified to conj. number 5.
35.	(2) SB! -	שבע	Reclassified to conj. number 5.
36.	SHQ -	שהק	Reclassified to conj. number 5.
37.	SW! -	שוע	Reclassified to conj. number 5.
38.	SHZ -	שחז	Reclassified to conj. number 5.
39.	SHL -	שחל	Reclassified to conj. number 5.
40.	SHM -	שחם	Reclassified to conj. number 5.
41.	SHF -	שחף	Reclassified to conj. number 5.
42.	SHZ̲ -	שחץ	Reclassified to conj. number 5.
43.	SHQ -	שחק	Reclassified to conj. number 5.

(L2) Reclassification

Construction He--Hitpaʿel-- התפעל --(ה) continued

44. SHR - שחר Reclassified to conj. number 5.
45. SHD - שחד Reclassified to conj. number 5.
46. STH - שטח Reclassified to conj. number 5.
47. SYK - שיך Reclassified to conj. number 5.
48. SYF - שיף Reclassified to conj. number 5.
49. SYR - שיר Reclassified to conj. number 5.
50. SKH - שכח Reclassified to conj. number 5.
51. SLH - שלח Reclassified to conj. number 5.
52. SN' - שנא Reclassified to conj. number 5.
53. SM! - שמע Reclassified to conj. number 5.
54. SS! - שסע Reclassified to conj. number 5.
55. S!L - שעל Reclassified to conj. number 5.
56. S!R - שער Reclassified to conj. number 5.
57. SP! - שפע Reclassified to conj. number 5.
58. SQ! - שקע Reclassified to conj. number 5.
59. TM' - טמא Reclassified to conj. number 6.
60. DK' - דכא Reclassified to conj. number 6.
61. TM! - טמע Reclassified to conj. number 6.
62. TRF - טרף Reclassified to conj. number 6.
63. KFR - כפר Reclassified to conj. number 6.
64. N'Z - נאץ Reclassified to conj. number 6.
65. NS' - נשא Reclassified to conj. number 6.
66. TRZ - תרץ Reclassified to conj. number 6.
67. SFRD - ספרד Reclassified to conj. number 17.
68. T!T! - תעתע Reclassified to conj. number 18.

(L2) Reclassification

Construction Waw-Hif!il--הפעיל--(ו)

1.	YLK -	ילך	Reclassified to conj. number 2.
2.	YZ' -	יצא	Reclassified to conj. number 2.
3.	NW' -	נוא	Also as conj. number 10. (הקימותי)

(L2) Reclassification

Construction Zayin--Hof!al-- הפעל --(ז)

1.	YZ' - יצא	Reclassified to conj. number 2.
2.	NTQ - נתק	Also as conj. number 1 (i.e. retaining the Nun (נ)).

(L3) Special Classes and Unclassified [1A]

Construction Alef--Pa!al-- פעל --(א)

In.	Conj. Model	
25.	Y'H - יאה	Same as number 10 (QNH--קנה) but participle lacks Waw (ו).
26.	YLK - ילך	Same as number 5 (YSB-- ישב) but has neither perfect nor participle forms.
27.	YZT - יצת	Same as number 6 (YZQ--יצק) but the perfect drops Taw (ת) as in number 14 (KRT-- כרת).
28.	YRS - ירש	Same as number 1 (SMR--שמר), but infinitive and imperative as in number 5 (YSB-- ישב).
29.	YRT - ירט	Same as number 1 (SMR--שמר), but also number 5 (YSB-ישב) except for imperative.
30.	NST - נשת	Imperfect also[1] preserves the Nun (נ) while dropping the Taw (ת) as in number 14 (KRT-- כרת).
31.	HGN - הגן	Present and passive participles only.

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[1] "Also," i.e. in addition to the corresponding regular conjugation noted in List 1 (L1).

[1A] This list is indexed as a continuation of list 1.

(L3) Special Classes and Unclassified

Construction Alef--Pa!al-- פעל --(א) continued

In.	Conj. Model	
32.	HLK - הלך	Same as number 1, but without imperative.
33.	ZQQ-- זקק 'RR-- ארר	Perfect also as in number 1.
34.	HYT - חית	Same as in 'Ayin-Yud (ע " y) but the Taw (ת) coalesces with the suffix Taw (ת).
35.	THH - טחח	Same as number 19 (HGG-- חגג) but participle as in number 20 (QBB-- קבב).
36.	!WT - עות	Infinitive construct only. Occurs with prepositional Lamed (L!WT--לעות)
37.	NST - נסס	Participle only NWSS (נוסס).
39.[1]	!ST - עשת	Same as number 14, but participle as in number 43.
40.	HWH - הוה	Same as number 10, but infinitive is HWH (הוה) and also HWY (הוי).
41.	PSS - פסס	Also as number 35 (THH-- טחח).
42.	ZRK - צרך	Participle also ZRYK (צריך) etc.
43.	The anomalous passive participles of the intransitives.	

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[1] Number 38 is missing.

(L3) Special Classes and Unclassified

Construction Bet--Nif'al-- נפעל --(ב)

In.	Conj. Model	
14.	HYH - היה	The perfect as in number 4 (GLH- גלה); the Yud (י) mutated to Waw (ו) in the present participle; no imperfect nor imperative.
15.	LNN - לנן	Same as number 12, but imperfect only; Nun (ן) coalesces with the suffixal Nun (ן).
16.	YRH - ירה	Pe-Yud (פ"י) Lamed-He (ל"ה), which has no preceeding model.
17.	NST - נשת	Same as number 7 but the first radical drops.
18.	SWT - סות	Same as number 10 but the Taw (ת) coalesces with the prefixical Taw (ת).
19.	YZB - יצב	Same as number 3, but occurs only in perfect and in the present participle.
20.	YZT - יצת	Same as number 19, but the Taw (ת) coalesces with the suffixical Taw (ת).

(L3) Special Classes and Unclassified

Construction Gimel-Pi!el--פיעל --(ג)

In.	Conj. Model	
10.	!WN - ערן LWN - לרן	Same as number 5, but Nun (נ) coalesces with suffixical Nun (נ).
11.	MWT - מרת ZWT - צות	Same as number 5, but Taw (ת) becomes coalesced with suffixical Taw (ת).
12.	SFTT - שפתת	Quadriliteral, final Taw (ת) coalesces with suffixical Taw (ת).

(L3) Special Classes and Unclassified

Construction Dalet--Pu!al--פּועל--(ד)

In.	Conj. Model	
10.	SFTT - שפתת	Quadriliteral, final Taw(ת) becomes coalesced with suffixical Taw (ת).

(L3) Special Classes and Unclassified

Construction He-Hitpa!el-- התפעל --(ה)

(Special classification based on changes governed by nature of first radical; namely Z, S, S, Ẕ , D, T, T-- (ז, ס, ש, צ, ד, ט, ת.

In.	Conj. Model	
20.	DDH - דדה	Same as number 7 (GLH- גלה) but the Taw (ת) of the prefix HT (הת) may also coalesce.
21.	DYT - דית	Same as number 9 but the Taw (ת) of the prefix HT (הת) becomes coalesced.
22.	DSN - דשן	Same as number 6, but the Nun (נ) coalesces with the suffixical Nun (נ).
23.	ZKH - זכה	Same as number 7, but the Taw (ת) is mutated to a Dalet (ד) and transposed.
24.	ZBN - זבן ZYN - זין ZMN - זמן ZQN - זקן	Same as number 8 but the Taw (ת) behaves as in number 23.
25.	ZWL - זול	Same as number 10 but the Taw (ת) behaves as in number 23.

(L3) Special Classes and Unclassified

Construction He-Hitpa!el-- התפעל --(ה)

In.	Conj. Model	
26.	SWD - סוד SWF - סוף SWB - שוב ŠWḤ - שוח ŠWF - שוף ŠWQ - שוק	Same as in number 10, but the Taw (ת) is transposed.
27.	TBN - תכן TQN - תקן	Same as in number 8, but the Taw (ת) coalesces.
28.	Z̲DD - צדד Z̲FF - צפף	Same as number 26, but the Taw (ת) is mutated to a Ṭet (ט) and is transposed.
29.	Z̲WT - צות Z̲MT - צמת	Same as in number 9 ('MT - אמת) but the Taw (ת) behaves as in number 28.
30.	Z̲WH - צוה Z̲FH - צפה	Same as in number 7, but the Taw (ת) behaves as in number 4.
31.	SWH - סוה SMH - סמה Š'H - שאה ŠDH - שדה ŠHH - שהה ŠWH - שוה ŠḤH - שחה ŠṬH - שטה ŠLH - שלה ŠSH - שסה Š!H - שעה ŠFH - שפה ŠRH - שרה	Same as in number 7, but the Taw (ת) behaves as in number 5.

(L3) Special Classes and Unclassified

Construction He-Hitpa!el-- התפעל --(ה)

In.	Conj. Model	
32.	ŠḤH - שחה	Same as in number 31, except with the addition of a Waw (ו) before the final radical position.
33.	S'N - סאן SBN - סבן SKN - סכן SMN - סמן SNN - סנן ŠKN - שכן ŠMN - שמן ŠNN - שנן Š!N - שען	Same as in number 8 ('MN - אמן) but the Taw (ת) behaves as in number 5.
34.	SNN - סנן ŠḤN - שחן ŠNN - שנן	Same as in number 33, but also as number 11.
35.	SBB - סבב SKK - סכך SLL - סלל SFF - ספף ŠḤḤ - שחח ŠLL - שלל ŠMM - שמם ŠQQ - שקק	Same as in number 10 (QWM - קום) but the Taw (ת) behaves as in number 5.
36.	Z̲ḤZ̲Ḥ - צחצח Z̲MZ̲M - צמצם Z̲MRR - צמרר Z̲!Z̲! - צעצע Z̲FZ̲F - צפצף Z̲RZ̲R - צרצר	Same as in number 4 (Z̲DQ - צדק) but the radical is quadriliteral.

(L3) Special Classes and Unclassified

Construction He-Hitpa!el-- התפעל --(ה)

In.	Conj. Model	
37.	SQRN -סקרן SRṬN -סרטן Š'NN -שאנן ŠRYN -שרין	Same as number 19 (!NYN - (ענין) but the radical is quadriliteral.
38.	T!T! -תעתע	Same as in number 6, but the radical is quadriliteral.

(L3) Special Classes and Unclassified

Construction Waw - Hif!il-- הפעיל --(ו)

In.	Conj. Model	
16.	LNN - לנן	Same as in number 10 (QWM - קום) but the Nun (נ) coalesces with the suffixal Nun (נ); also as number 11, but the Nun coalesces as above.
17.	YZ̲T - יצת	Same as in number 12, but the Taw (ת) coalesces with the suffixal Taw (ת).
18.	KTT - כתת	Same as in number 15 (TLL - תלל) but also the Taw of the second radical coalesces with the suffixal Taw (ת) leaving only a monoliteral stem.

(L3) Special Classes and Unclassified

Construction Zayin--Hof!al--הופעל--(ז)

In.	Conj. Model	
13.	YZ̲T - יצת	Same as in number 3, but the Taw (ת) becomes coalesced with the suffixical Taw (ת).
14.	NTN - נתן	Same as in number 4, but in imperfect only.
15.	LQḤ - לקח	Same as in number 1, but the first radical coalesces.

Comments

Because of shortcomings in the basic research material, which we felt obliged to utilize, error was unavoidable. Nevertheless, because of greater efficiency for conducting the studies which the scholar has been thus endowed as a result of our investigation, we are confident that these shortcomings and consequent errors will be eliminated individually, as the case may demand. Naturally, with continued utilization of our studies, error will be completely effaced for all practical purposes.

Lack of means has compelled postponement of continuation of the research in respect to a number of important and highly relevant problems. An example of this is afforded by certain ommissions that have been made in matters that have bearing on verb classification. In general, these matters are of the nature of generalizations that are relatively of wider universal relationship in the field of verb classification. For example, the jussive (apocapated imperfect) has not been discussed here. We look forward to the integration of these and similar matters into the future programming of the computer.

VI Results and Discussion

Results:

The computer technique employed in the research consistently identified stems of the test-words. These stems invariably were validated by objective criteria. Though the research is at present not entirely completed, optimism as to the character of further results is, therefore, justified.

Discussion:

The results of the research very evidently indicate that the computer can take over the human function of identifying stems of the language with equal and even greater accuracy, but with incalculably greater speed. Semantic difficulties, however, remain in which the machine cannot compete with the human operator. But the one gain alone -- the tremendous speed with which the computer carries out its assignment -- is a priceless one, and will now make feasible such projects as compiling of concordances, indices, special dictionaries, classified lists of data, and other scholarly and pedagogic works.

Nevertheless, there still remains a serious problem of increasing the efficiency of the computer technique through reduction and streamlining of the many sub-operations involved in the technique.

There is also envisioned beneficial modification and expansion of the correlation tables in keeping with the provenanced of additional data characterized by special problems. For example, no distinction has been drawn between imperfect and imperative in the usage of cohortative hé.

Though the present tables are adequate and quite satisfactory for our purpose, it may be advis~~e~~able to broaden their application for such projects as translation inquiries. In case of our example, this would require a redivision of the data involved into two separate rows, one corresponding to the imperfect, the other, to the imperative.

VII CONCLUSIONS

General Value:

It can be stated with confidence that the special method of research which we have undertaken, though as yet incomplete, already represents a most valuable technique for future studies in this and and related fields. Hitherto, application of computer techniques to language research, in general, and to studies in Hebrew, in particular, have been of a rather routine or statistical character. The research described in this report, it is to be hoped, can justifiably be termed a pioneer step insofar as it has pointed out the way wherein computer studies in this field may truly be invested with the ability of scholarly progress. This has been done by translating the need for encyclopedic consultation in analytic studies of Hebrew words into the routine, mechanical technique afforded by design of an appropriate rationale and scheme for computer operation, which effectively translates the need for encyclopedic consultation in this field to the routine, simpler way of the computer. In brief, our research should make preparation and availability of technical works in the field of linguistics a routine, relatively speedy task. This, in itself, will have a double value. On the one hand, it will furnish the researcher with sufficient and needy material to carry out research on his own special problem; and on the other hand, it will provide the scholar much more leisure so essential for the functioning of the creative imagination basic for advance in all fields of learning.

Specific Application - A New Pedagogic Approach: In addition, our special research already indicates valuable and ~~and~~ immediate application to the field of pedagogics of language and new insights in the understanding of the basic laws of the Hebrew tongue itself.

We permit ourselves an additional passing comment at this point in relation to an outstanding example of application of the results of our research to the teaching of Hebrew. To reiterate, our study has essentially emphasized to an unusual degree the morphologic aspect of Hebrew grammar. The observations that have come to light in the course of our research have pointed out and confirmed that the role played by vocalization and the rules governing vocalization are in reality of minimal importance from the point of view of transmitting insight and broader understanding of the mechanics and structure of the Hebrew language.

In truth, what has become apparent is that by basing studies of the language on the experience gained through our research, an overall perspective is afforded which will silhouette more clearly the inter-relations and inter-connections of the Hebrew language. It is very evident, therefore, that pioneering work in this direction is definitely indicated, certainly, for institutions of higher learning.

VIII. Summary:

The purpose of the study was the construction of an algorithm for stem recognition in the Hebrew language. The Hebrew word was conceived as a consonantal, morphologic unit, and this concept governed the more detailed planning of the research. Thus, vowel changes were not considered. Central to the entire research were tables and listings organized on a grammatical basis and so devised as to present certain pertinent correlations between verbals and nominals and theaffixal elements.

36 grammatical categories were set up: constructions, modes, tenses, person, number, gender, accusative pronominals for verbs, construct state, person, number gender for nouns. Four types of affixes were correlated with these categories. The four types were: auxiliary elements, prefixes, suffixes, accusative pronominals.

A sequence of programs was written for the computer. First, it was enabled to fractionate a test word on the basis of the prepared lists, thus separating the verb or noun stem from the affixes. Empirical rules were then formulated for the purpose of assisting the computer in arriving more accurately at the grammatically correct combination. Utilizing the tables, the computer checked further the various combinations of stem and affix for grammatical legitimacy. Each fractionation of a given tested word which has been identified as one of the affixes listed was checked against the 36 columns of grammatical categories.

In order to further check the validity of the residue combinations, the final products of the computer operation, it became necessary to check the associated stems. For this purpose, a special reference dictionary is now being compiled. The dictionary is divided into two sections-the verbal and nouns. Each entry of the noun section is especially indexed. The index number identifies for the computer the table which indicates the different mutations of which the entry is capable. In addition, the dictionary contains 12 more features.of other pertinent information as well.

The verbs have been compiled iin separate tables. The entries are indexed and analogously, as in case of the nouns, the computer is thus enabled to obtain full information on the tested verb. At times the tested residue will be reported as noun or verb; at times, as noun and verb. The latter is morphologically possible.

The research here summarized though incomplete, has simplified the academic problems involved in the field of investigation of Hebrew words, and has reduced their solution to routine, mechanical terms. Perhaps most spectacular isthe application of the results of our investigation to the field of teaching. Traditionally the magnitude of attention paid to the aspect of vocalization of Hebrew grammar has been very great. Our studies however indicate that this measure of preoccupation with vocalization has been unduly extensive. The system of Hebrew language instructions oriented in morphology, as marked out in this report, will not only ease the labor of the students, but will also convey a much more significant and valuable understanding of the structure and dynamics of the language.

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Lazewnik, Grainom

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RETRIEVAL TERMS

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ABSTRACT

In this study the Hebrew word was conceived as a consonantal, morphologic unit. This concept governed the more detailed planning of the research. Central to the entire research were tables and listings organized on a grammatical basis and so devised as to present certain pertinent correlations between verbals and nominals and the affixal elements. Thirty-six grammatical categories were set up. Four types of affixes were correlated with these categories. The computer technique consisted of fractionating test words into previously defined elements and forming the various combinations subsequently subjected to validation. The technique operations were founded essentially on specially devised grammatical correlation tables and certain empirical rules. A special reference dictionary is now being compiled for the purpose of testing the residuum of grammatically legitimate combinations. The results of the computer functioning remained validated by objective criteria. The indications are that valuable contributions have thus been made to the advancement of scholarship in linguistics and that new dierections have been mapped outto the greater enhancement of the art of language teaching.

Figure 3